Chapter 3 — Affected Environment

This chapter describes the affected environment for the project alternatives. The affected environment is the portion of the existing environment that could be affected by the project. The information presented here focuses on issues identified through the scoping process and interdisciplinary analyses.

The affected environment varies for each issue. Both the nature of the issue and components of the proposed project and alternatives dictate this variation. The following sections concentrate on providing only the specific environmental information necessary to assess the potential effects of the Proposed Action and alternatives.

Groundwater

Regional Characterization

Groundwater resources are contained in permeable underground aquifers comprised of rock and sediments through which water can flow. Water moves slowly in aquifers in response to the prevailing hydraulic gradient, through tiny open spaces in the rock and sediment. Groundwater is replaced, or recharged, from precipitation that falls directly on the aquifers or by leakage through the beds of streams that intercept aquifers or from adjacent aquifers. Groundwater movement is from recharge areas down the hydraulic gradient to discharge areas.

Aquifer permeability is directly related to the nature and type of porosity of the material comprising the aquifer. Primary porosity is the open space between individual grains or rock clasts. Secondary porosity consists of joints and fractures that form after a rock is consolidated (Whitehead 1996). Primary porosity is the porosity type of unconsolidated-deposit aquifers and consolidated sandstone aquifers in the PRB (Whitehead 1996). Coal aquifers in the PRB contain significant secondary porosity.

Davis (1976) describes groundwater resources as part of a hydrologic system. The components that describe a hydrologic system are the following: aquifer type (or geologic unit); water chemistry; confined (artesian) or unconfined conditions; and groundwater recharge or discharge areas.

Aquifer Types

The groundwater resources of the PRB are described by Whitehead (1996). Groundwater resources that are at or near the land surface within the PRB are contained in unconsolidated Quaternary alluvial or basin fill deposits or in semi-consolidated to consolidated lower Tertiary sandstones and coal beds that are the uppermost aquifers in the Northern Great Plains aquifer system. Clinker, which is also an aquifer, has formed from some of the lower Tertiary sediments (Heffern and Coates 1999). These Quaternary and Tertiary aquifers are described below in more detail.

Quaternary Alluvial Aquifers

Aquifers in stream-valley alluvium generally occur along rivers and major drainages within the PRB. The groundwater resources contained in alluvial aquifers are described by Whitehead (1996). These unconsolidated deposits of silt, sand, and gravel occur as floodplains, stream terraces, and alluvial fans. Coarser alluvial deposits occur in valleys of the Belle Fourche, Cheyenne, Powder, Tongue, and Little Powder rivers and in the larger tributaries of the Powder and Tongue rivers. Alluvium overlying formations of Tertiary age in the central part of the PRB is mostly fine to medium grained (Hodson et al. 1973).

The thickness of alluvial deposits within the Project Area is mostly less than 50 feet, but may be as much as 100 feet in some valleys near mountains (Hodson et al. 1973). Wells (1982) describes alluvial deposits as commonly 30 feet or less thick, but also reports that deposits 100 feet thick have been measured. Lowry et al (1986) also describe alluvial deposit thickness and water yield from the PRB. The thickest and coarsest-grained alluvium occurs near the Bighorn Mountains along the western margin of the PRB, where saturated horizons are thick and high yields of water are possible. Mostly fine-grained alluvial deposits having a saturated thickness less than 20 feet occur distant from the mountains, resulting in low yields of water.

Northern Great Plains Aquifer System

The Northern Great Plains aquifer system is an extensive sequence of aquifers and confining units arranged in a stack of layers that may be discontinuous locally within the PRB, but which functions regionally as an aquifer system. This system includes the lower Tertiary aquifers that are exposed at the surface in the PRB and underlying, deeply buried regional aquifers that are stacked with intervening confining layers. The deeply buried aquifer systems are comprised of upper Cretaceous sandstones and coals, lower Cretaceous sandstones, upper Paleozoic limestones and dolomites, and lower Paleozoic sandstones, limestones, and dolomites (Whitehead 1996). These deeply buried regional aquifers are stratigraphically below, isolated from, and older than the aquifers that may be affected by CBM development in the PRB and are not described further.

Lower Tertiary Aquifer System

The lower Tertiary aquifer system consists of semi-consolidated to consolidated Oligocene to Paleocene sediments (Whitehead 1996). The Oligocene White River Formation is present in the Project Area only as isolated erosional remnants, such as Pumpkin Buttes in southwestern Campbell County (Lewis and Hotchkiss 1981), and is not described further.

The lower Tertiary aquifers consist of sandstones and coal seams contained in the Eocene Wasatch Formation and the Paleocene Fort Union Formation (Whitehead 1996). Both of these geologic units are continental deposits consisting of sandstones, siltstones, claystones, and beds containing lignite and subbituminous coal. Stratigraphically, from youngest to oldest, the Lower Tertiary Aquifer System consists of the Wasatch aquifers, the Fort Union aquifers contained in the Tongue River member of the Fort Union Formation, the Lebo confining layer, and the Tullock aquifer. In locations where these sediments have been altered in place by spontaneous combustion of coal beds, clinker has been formed from these geologic formations (Coates and Heffern 1999).

Clinker plays an important role as an aquifer in the storage and flow of water within the PRB. Rainfall and snowmelt infiltrate rapidly in clinker exposure areas. The stored water is discharged slowly to springs, streams, and aquifers, which helps maintain flow in perennial streams during dry periods (Heffern and Coates 1999). Clinker outcrops cover about 460 square miles of the Project Area and are concentrated in the following areas: along the eastern boundary of the Project Area in the Rochelle Hills, within the Powder River Breaks in the northern portion of the Project Area, within the Tongue River Breaks north of Sheridan, within the Lake De Smet area north of Buffalo, and within the Felix coal outcrop area west of Gillette and northeast of Wright (Heffern and Coates 1997).

Wasatch Aquifers

The Wasatch Formation consists of fine- to coarse-grained, lenticular sandstone interbedded with shale and coal (Hodson et al. 1973). Minor constituents include coarse conglomerates occurring along the western margin of the PRB, carbonaceous shales, and thick coal beds (Seeland 1992). Sandstone layers comprise an estimated one-third of the sequence and are important PRB aquifers. High percentages of sand (from 30 to 50 percent and more) have been documented along a trend paralleling the western margin of the PRB, beginning east of Buffalo and west of the Powder River and continuing toward the southeast (Seeland 1992). Wasatch coal beds are thickest in the central and western portions of the PRB (Seeland 1992). Locally, in the northwest part of the PRB near the Bighorn Mountains, the Wasatch is divided into two conglomeratic members.

The Wasatch Formation is as much as 1,800 feet thick in the southern portions of the PRB (Keefer 1974). Southeast of Buffalo, the maximum preserved thickness of the Wasatch Formation is about 3,000 feet (Seeland 1992).

Fort Union Aquifers

The Fort Union Formation yields water from fine-grained sandstone, jointed coal, and clinker overlying the Lebo confining layer (Zelt et al. 1999). The Fort Union aquifer has a sandstone content ranging from 21 to 91 percent and is hydrologically confined, except near the land surface (Hotchkiss and Levings 1986). The Fort Union Formation is as much as 3,900 feet thick in the southern part of the PRB (Hotchkiss and Levings 1986).

Numerous thick and laterally widespread coal beds occur within the Fort Union Formation and are important PRB aquifers (Lewis and Hotchkiss 1981). The thickness of the Fort Union coal aquifers varies greatly within the PRB. The maximum thickness of a single Fort Union coal seam is less than 25 feet along the western margin of the PRB and in the northern portion of PRB in southeastern Montana. The maximum thickness of a single Fort Union coal seam is more than 100 feet near Wright and extending west and northwest of Wright, within the central portion of the PRB in Wyoming (Seeland 1992).

Lebo Confining Layer

The lower Paleocene Tullock member of the Fort Union Formation is partially isolated and confined by the overlying Lebo member (Brown 1993). The Lebo confining layer generally retards water movement (Hotchkiss and Levings 1986).

The Lebo confining layer consists predominantly of dark shales containing discontinuous zones of white calcareous banding (paleosol horizons). In the northern portion of the Project Area, the Lebo contains rare beds of gray sandstone as much as 10 feet thick. In the southern PRB some coal beds, a few thicker than two feet, occur within the Lebo and form clinker horizons. The Lebo member ranges in thickness from about 500 feet in the northwestern portions of the PRB to about 1,700 feet in the southwestern portions of the PRB (Brown 1993).

Tullock Aquifer

The lower Paleocene Tullock member of the Fort Union Formation contains alluvial sediments deposited in a continental fluvial environment and is an important PRB aquifer. The Tullock aquifer consists of fine-grained sandstone, sandy siltstone, shale, rare thin limestone, and coal. Sandstone content of the Tullock aquifer ranges from 21 to 88 percent (Hotchkiss and Levings 1986). But, on average, an estimated one-third of the sequence is comprised of channel sandstones. An estimated two-thirds of the sequence is comprised of fine-grained overbank deposits containing thin coal beds (Brown 1993).

Tullock sediments have a maximum thickness of about 370 feet in the north and 1,440 feet in the south (Brown 1993). Tullock sediments are thickest in the southeastern and western portions of the PRB.

Groundwater Chemistry

Water quality in alluvium within the PRB is quite variable. Lowry et al (1986) report concentrations of total dissolved solids (TDS) for alluvial aquifers varying from 106 to 6,610 mg/L, and averaging 2,128 mg/L for 38 samples. Water from surficial deposits that contain less than 600 mg/L TDS may be divided into two chemical types, a calcium magnesium carbonate type and a calcium magnesium sulfate type (Rankl and Lowry 1990). TDS concentrations greater than 600 mg/L generally are due to increased values for sodium and sulfate (Rankl and Lowry 1990). Water in alluvium near the Bighorn Mountains and the Black Hills is better quality than water in alluvium in the central part of the PRB. Water in alluvium in the southwest part of the basin and in the Powder River valley is generally poorer quality than water in alluvium elsewhere in the PRB. No dominant water type is prevalent (Hodson et al. 1973).

The chemical compositions of water in the Powder River and in the river's alluvium are similar (Ringen and Daddow 1990). Water in the Powder River is dominated by sodium and sulfate ions, while water in the river's alluvial deposits is dominated by sodium, calcium, and sulfate ions. The water in the underlying bedrock is dominated by sodium and bicarbonate ions. The quality of water in the alluvium limits its use as a water supply, being unacceptable for drinking water, acceptable for most livestock, and marginal for irrigation or industrial use.

The quality of water in the Wasatch aquifer within the PRB is quite variable. Lowry et al. (1986) report TDS concentrations for Wasatch aquifers varying from 227 to 8,200 mg/L, and averaging 1,298 mg/L for 191 samples. Sodium sulfate and sodium bicarbonate are the dominant water types (Hodson et al. 1973). Dahl and Hagmaier (1976) describe groundwater chemistry changes along the regional flow path in the vicinity of the Highland uranium deposits in the southern PRB. The chemistry changes from a sulfate-rich groundwater with minor bicarbonate in the recharge area southwest of the Highland area to a bicarbonate-rich groundwater in the discharge area northeast of the uranium deposits. This change in chemistry is attributable to sulfate reduction, which decreases sulfate concentration and increases bicarbonate concentration.

Rankl and Lowry (1990) describe the change in chemical quality of water in the Lower Tertiary aquifer system with depth in the PRB, obtained through an analysis of USGS data from water wells and springs. There is a decrease in calcium, magnesium, and sulfate and an increase in bicarbonate down to a depth of about 500 feet; however, deeper than 500 feet the concentration of dissolved constituents is relatively uniform.

Hodson et al (1973) provide an overview of water quality in the Fort Union aquifers. Concentrations of TDS range from about 200 to more than 3,000 mg/L, but commonly range between 500 and 1,500 mg/L. Water type is mostly sodium bicarbonate and, to a lesser extent, sodium sulfate. The dominant chemical reactions that control the chemistry of Fort Union groundwater are cation-exchange softening and sulfate reduction (Rankl and Lowry 1990). The water from deep wells is soft, meaning sodium plus potassium exceeds calcium plus magnesium, and many water samples contain carbonate as well as bicarbonate (Rankl and Lowry 1990).

Davis (1976) describes the chemistry of groundwater of the Fort Union aquifer within the eastern PRB. Along the coal outcrop, the water generally is calcium-magnesium sulfate type, changing to sodium bicarbonate type westward where confined aquifer conditions exist. There is a relationship between the confined and unconfined state of the aquifer and the chemical quality of water within the aquifer. As a general rule, waters within unconfined portions of the coal aquifer are calcium-magnesium-sulfate type and those within confined portions of the aquifer are sodium bicarbonate type.

CBM development within the PRB has generated detailed water quality information for the coal zone aquifers within the Fort Union aquifer (Rice et al. 2000, Energy Labs 2001, Flores et al. 2001). Table 3–1 summarizes basinwide CBM produced water composition for the PRB.

The quality of CBM produced water in the Project Area is summarized in Table 3–2. CBM produced waters in the Project Area have mean TDS concentrations that range from 770 mg/L in the Upper Belle Fourche River sub-watershed, to about 3,000 mg/L in the Middle Powder River sub-watershed. These CBM produced waters are typically slightly alkaline, hard sodium bicarbonate, and sodium sulfate type waters.

Table 3–1 Powder River Basin Produced Water Composition

Parameter (units)	Range	Average	DWS[1]
pH (standard units)	6.8-7.6	7.2	6.5-8.5
TDS (mg/L)	300-1,900	740	500
Chloride (mg/L)	5.3-64	16	250
Sulfate (mg/L)	0-17	3.3	250
Bicarbonate (mg/L)	330-2,300	850	---[2]
Calcium (mg/L)	9.1-69	35	---[2]
Potassium (mg/L)	4.1-19	9.3	---[2]
Magnesium (mg/L)	3.4-46	17	---[2]
Sodium (mg/L)	110-710	240	---[2]

Source: Flores et al. 2001
Notes:
1 DWS means national Drinking Water Standard
2 --- means no recommended values

Concentrations of TDS within clinker varies widely from under 500 mg/L to more than 7,000 mg/L. Water in clinker from recharge areas near the burn line tends to be a calcium sulfate type and water in clinker from discharge areas tends to be a sodium bicarbonate type similar to water in the coal. Ash residue at the base of the clinker may contribute to high TDS concentrations (Heffern and Coates 1999).

Rankl and Lowry (1990) provide an overview of water chemistry for water wells in the PRB. Water wells, excluding municipal water supply wells, generally are shallow (less than 500 feet deep) and generally yield calcium sulfate or calcium sodium sulfate waters. Deep wells generally yield sodium bicarbonate type water.

Confined (Artesian) vs. Unconfined Conditions

The groundwater resources contained in alluvial aquifers are under unconfined or water table conditions (Whitehead 1996). Normally, clinker is an unconfined aquifer (Heffern and Coates 1999). Groundwater resources contained in the Wasatch aquifers occur under partially confined conditions (Whitehead 1996).

The Fort Union coal zone aquifers are hydrologically confined, except near the land surface (Hotchkiss and Levings 1986). The underlying Lebo confining layer generally retards water movement (Hotchkiss and Levings 1986). The lower Paleocene Tullock member of the Fort Union Formation is partially isolated and confined by the overlying Lebo member (Brown 1993). The Tullock aquifer is hydrologically confined, except near outcrop areas (Hotchkiss and Levings 1986).

Table 3–2 CBM Produced Water Quality in the Powder River Basin

		Constituent															
Drainage		Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Bicarbonate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Specific Conductance (umhos/ centimeters)	Sodium Adsorption Ratio	pH (Std. Units)	Arsenic (µg/L)	Barium (µg/L)	Iron (µg/L)	Manganese (µg/L)	Selenium (µg/L)
Upper Powder River	Minimum	7	5	18	4	51	2	U[1]	214	342	0.1	6.8	U	U	30	U	U
	Mean	120	89	497	13	1,065	19	548	1,884	2,428	13.5	7.7	1.78	422	76.7	156	0.052
	Maximum	646	528	1,470	35	3,080	152	4,260	7,210	7,460	40	8.6	23.4	1,400	1,080	8,500	5
	Count	107	107	108	72	76	112	106	124	221	146	124	177	9	135	134	96
Middle Powder River	Minimum	190	121	184	9	427	6	1,360	2,300	2,700	2.1	7.6	0.6	U	30	50	U
	Mean	270	199	325	11	597	21	1,745	2,977	3,423	3.7	7.6	0.9	U	42.9	601	0.83
	Maximum	424	265	539	14	934	37	2,410	3,830	4,030	7.2	7.6	1.3	U	100	2,230	5
	Count	12	12	12	12	12	12	12	12	12	12	1	6	1	7	7	6
Little Powder River	Minimum	8	4	78	3	220	5	U	495	616	2.4	6.7	U	U	30	U	U
	Mean	82	88	393	10	792	18	90	1,170	2048	8.9	7.1	0.62	1,014	414	174	0.08
	Maximum	428	1,020	2,080	15	1,370	740	5,660	8,810	12,740	14.5	8.4	16.9	1,400	9,600	10,100	1
	Count	133	133	134	19	30	162	128	147	321	159	196	167	7	182	172	62
Antelope Creek	Minimum	48	14	223	NA[2]	NA	18	2	698	1,130	7.3	NA	0.59	NA	NA	NA	U
	Mean	48	14	223	NA	NA	18	2	698	1,130	7.3	NA	0.59	NA	NA	NA	U
	Maximum	48	14	223	NA	NA	18	2	698	1,130	7.3	NA	0.59	NA	NA	NA	U
	Count	1	1	1	0	0	1	1	1	1	1	0	1	0	0	0	1
Upper Cheyenne River	Minimum	11	5	111	4	NA	3	U	323	542	6.2	6.5	0.5	NA	390	U	U
	Mean	14	7	128	5	NA	8	2	402	787	7.0	7.0	1.65	NA	390	5	U
	Maximum	18	9	143	6	NA	10	4	677	1,160	8.5	8.1	3.3	NA	390	10	U
	Count	8	8	8	8	0	14	8	9	58	9	13	23	0	1	2	9
Upper Belle Fourche River	Minimum	10	4	131	3	330	1	U	2	1	2.9	6.7	U	U	30	U	U
	Mean	37	16	264	8	834	14	18	770	1,202	9.1	7.1	0.51	300	617	43.2	0.13
	Maximum	134	93	420	20	1,400	36	1,080	1,790	2,460	15.5	8.4	5.4	800	7,750	370	8
	Count	130	133	126	112	80	217	200	189	840	131	163	284	8	121	124	150

Notes:
1. U = Undetected.
2. NA = Not Analyzed

Source: Energy Labs 2001

Groundwater Flow Systems (Groundwater Recharge vs. Groundwater Discharge Areas)

Groundwater discharge from the Project Area is principally by groundwater outflow; by loss to gaining streams, springs, and seeps; by evapotranspiration; and by well pumpage (Hotchkiss and Levings 1986). The regional pattern of groundwater flow is complicated by lenticular (discontinuous) beds and local differences in hydraulic conductivity (how the water moves through the aquifer). Water in the lower Tertiary aquifers generally moves northward from recharge areas at higher elevations toward discharge areas at lower elevations (Whitehead 1996). The regional trend of movement changes locally where the aquifers discharge water to large streams, primarily within the lower portions of the Powder River drainage in the Project Area.

Rankl and Lowry (1990) describe groundwater flow systems in the PRB. Northward regional groundwater flow is expected in the PRB from potentiometric data that relate the position of the underground aquifers with respect to the topography of the land surface and streams. Groundwater (potentiometric surface) data suggest most streams in the PRB should receive base flow (groundwater discharge) from a regional groundwater system. However, streamflow records do not support this conclusion. The locations of streams having base flows and the period of time that base flows occur indicate base flows are discharged to surface waters from local groundwater systems rather than a regional system. Additionally, groundwater discharge areas have not been identified in the northern part of the Project Area on the basis of chemistry of springs and shallow wells. The chemical quality of shallow groundwater in the northern part of the PRB is affected more by local conditions than by regional flow.

Rankl and Lowry (1990) analyzed data from streamflow gaging stations on streams that originate in the area underlain by the Lower Tertiary Aquifer System and have five or more years of record. Base flow occurring during the period of greatest precipitation, but not after the growing season, indicates that base flow is from a local system dependent upon precipitation for each year's discharge. Much of the groundwater discharge from bedrock aquifers is above stream level and is lost due to evapotranspiration, resulting in no measurable contribution to base flow. Within the Project Area, only the Little Powder River had measurable groundwater contribution (1 cfs) during the non-growing season. Groundwater contribution of less than 1 cfs was indicated for the Belle Fourche River and Dead Horse Creek (near Buffalo). No groundwater contribution was indicated for Black Thunder Creek or the Cheyenne River.

The major sources of groundwater recharge are infiltration of water from precipitation, streamflow on areas of outcrops, or losing streams, including some perennial stream reaches along the front of the Bighorn Mountains. Regional groundwater flow simulations performed by Hotchkiss and Levings (1986) indicate recharge by direct precipitation accounted for about 30 percent of the total recharge.

Heffern and Coates (1999) describe the role of clinker in the storage and flow of water in the PRB. Normally, clinker outcrop areas are highly permeable, allowing rapid infltration of rainfall and snowmelt and then slowly discharging the stored water to springs, streams, and aquifers. This stored water helps maintain flow in perennial streams during dry periods.

Davis (1976) describes groundwater recharge and discharge within the eastern PRB. Most of the eastern PRB is a recharge area for the groundwater system below the Wasatch Formation. There are no perennial streams in the vicinity of the coal outcrop. The scoria (clinker) along the coal outcrop appears to be a very important area of recharge to the coal aquifers. Stream valleys provide primary recharge areas for the Wasatch Formation.

Within the Project Area, the Powder River loses water to the alluvium in the reach from Sussex to the State line, with the loss attributed to evapotranspiration from the alluvium (Rankl and Lowry 1990). This type of system is common in the Project Area. The average loss of flow per valley mile in the Project Area along the Powder River below Arvada was 0.31 cfs during late fall and early winter, as reported by Rankl and Lowry (1990).

Ringen and Daddow (1990) describe the hydrology of the generally fine-grained alluvial deposits occurring along the Powder River, within and near the Project Area. Alluvium ranges from 4 to 45 feet thick, but commonly is 10 to 30 feet thick and about one-half mile wide. The alluvium has direct hydraulic connection to the river. Water in the alluvium is supplied primarily by the river, which goes dry periodically. Seepage from the Powder River is stored in the alluvium during periods of high streamflow and is discharged back to some reaches of the river during low flow. Flow-duration curves and stream gain-loss analyses indicate that groundwater discharge, or irrigation return flow, or both contribute to streamflow during low flow conditions at Sussex, but not at Arvada or downstream from Arvada, where the discharge is lost through evapotranspiration.

Water Yield

Water yields of about five to 1,000 gpm from PRB alluvial aquifers have been reported (Hodson et al. 1973, Lewis and Hotchkiss 1981). Zelt et al (1999) report a water yield of 5 to 100 gpm for alluvium. Water yield from PRB alluvial deposits is constrained in areas where the alluvium is fine grained (Rankl and Lowry 1990).

Water yields from Wasatch/Fort Union sandstone, coal, or clinker deposits have been described by Lewis and Hotchkiss (1981). In the southern part of the PRB, yields as great as 500 gpm may be possible from sandstone or clinker deposits, with proper well construction techniques. Well yields of 10 to 50 gpm have been measured. Zelt et al. (1999) report a water yield of about 3 to 50 gpm in the northern PRB, becoming greater moving southward in the PRB, with about 500 gpm or more possible in the southern PRB. Water yields from the Fort Union aquifer reported by Zelt et al. (1999) are about 3 to 160 gpm. Hodson et al. (1973) report a maximum water yield of about 150 gpm.

Static levels of water in water wells and water yields from wells have been affected by coal mining and CBM development in the PRB. Meyer (1999) summarizes the drawdown of hydrostatic head in the Wyodak Anderson coal zone from

1980 to 1998. Existing drawdowns of the hydrostatic head in wells are interpreted to be 100 to 300 feet in extensively developed areas. However, water levels can vary considerably over short distances due to changes in geologic conditions. The greatest existing drawdowns are interpreted to occur in the following four townships: T.47N. R.72W.; T.48N.R.72W.; T.47N. R.73W.; and T.48N. R.73W. Figure 3–1 shows existing drawdown within the Project Area.

CBM development within the PRB has generated detailed water yield information for the coal zones within the Fort Union aquifer. Water production data acquired from CBM wells in the PRB are summarized by sub-watershed area (hydrologic unit) for 2000 in Table 3–3.

Table 3–3 2000 Water Production from CBM Wells for the Powder River Basin, WY

Sub-watershed	Pre-2002 CBM Wells[1]	Water Production (barrels)
Upper Tongue River	815	6,590,722
Upper Powder River	2,808	42,736,739
Crazy Woman Creek	150	28,706
Clear Creek	389	43,877
Middle Powder River	727	7,563,589
Little Powder	1,813	66,667,649
Antelope Creek	253	1,769,502
Upper Cheyenne River	454	48,491,981
Upper Belle Fourche River	4,662	200,409,537
Middle North Platte River	6	0
Total	12,077	374,302,302[2]

Source: WOGCC 2001b.
Notes:
1. Pre-2002 wells include all wells drilled or projected for completion by 2002 (not all are producing).
2. The total varies slightly from the non-GIS 2000 Production Statistics posted on WOGCC's website (374,787,920).

Water yield from the Lebo confining layer has been described by Lewis and Hotchkiss (1981). Wells penetrating a sufficient saturated thickness of lenticular channel deposits may yield as much as 10 gpm.

Water yield from the Tullock aquifer has been described by Lewis and Hotchkiss (1981). Fine-grained sandstones and jointed coal beds may yield as much as 40 gpm, but yields of 15 gpm are more common. Where the aquifer is confined, wells generally flow less than 10 gpm.

Groundwater Use

Rankl and Lowry (1990) describe water wells and groundwater use in the PRB. Water wells generally are less than 500 feet deep and principally support livestock and domestic uses. These shallow wells generally produce calcium sulfate or calcium sodium sulfate waters. Yields from shallow wells completed in sandstone aquifers generally are about 20 gpm. Deep wells yield larger quantities of water that generally is a sodium bicarbonate type. Water from alluvium has not

Figure 3–1 Interpreted 2000 Water Well Drawdown Contours

been developed extensively because the underlying Tertiary aquifers contain better quality groundwater and yield higher volumes of water.

Permitted, non-CBM groundwater withdrawals are summarized for the Project Area in Table 3–4. Almost 25 percent of the nearly 27,000 permitted, non-CBM water wells in the PRB are used for domestic purposes. About 1.5 percent of the permitted wells provide for irrigation or municipal uses. The remaining nearly 75 percent of the water wells in the Project Area are used for stock watering and other purposes.

Table 3–4 WSEO-Permitted Non-CBM Wells in the Project Area

Well Type	Formation Name[1]	Number of Wells
Domestic	Fort Union	2,218
	Wasatch	3,173
	Unknown	1,192
	Total	6,583
Irrigation	Fort Union	45
	Wasatch	92
	Unknown	117
	Total	254
Municipal	Fort Union	50
	Wasatch	42
	Unknown	43
	Total	135
Other	Fort Union	6,771
	Wasatch	9,115
	Unknown	4,088
	Total	19,974
Total		26,946

Note:
1. Applied Hydrology, Inc. (Bedard 2001) associated formation names with completed wells wherever well depths were available from WSEO data.

Sources: Bedard 2001, WSEO 2001

An estimated 46 percent of the permitted non-CBM water wells in the Project Area are completed in the Wasatch Formation. An estimated 34 percent of the permitted non-CBM water wells are completed in the Fort Union Formation. No formation name is available for the remaining almost 20 percent of the wells.

Figure 3–2 shows the relative numbers of permitted water wells and existing CBM wells located within the Project Area. The Upper Belle Fourche River and the Upper Tongue River sub-watersheds contain the largest number of permitted non-CBM water wells, 23 percent and 16 percent of the totals for the Project Area, respectively.

Surface Water

Regional Characterization

The Project Area is contained within several large river basins, which are headwaters to the much larger Missouri River Basin. Major rivers in the Project Area include the Powder River, Little Powder River, Tongue River, Belle Fourche River, and Cheyenne River. The major river valleys have wide flat floors and broad floodplains. Tributaries in the Project Area are incised and drain areas of isolated, flat-topped, clinker-covered buttes and mesas, 100 to 500 feet above the valley floor. Flow in the Project Area is generally towards the northeast. Perennial streams generally originate in the mountainous areas as a result of significant annual precipitation and geologic conditions that foster groundwater discharge.

The Project Area is semi-arid with average annual precipitation ranging from 12 to 16 inches. Normal annual precipitation increases generally eastward in the downstream direction (Taylor 1978). The majority of annual runoff in streams draining mountainous areas occurs during spring and early summer as a result of snowmelt. Nearly one half of the average annual precipitation occurs during the months of April, May, and June (Rankl and Lowry 1990). Streamflow generally peaks during June; however, this varies from year-to year depending on both local weather conditions and physical features of individual basins. Late summer, fall, and winter flows are largely the result of ground-water inflows. Minimum streamflows occur generally from January through March (Lowham 1988).

Surface water quality in the Project Area is generally adequate to support designated uses. Surface waters in the Project Area are typically alkaline, with moderate to high levels of hardness. These waters vary from a calcium bicarbonate type water in the mountain streams, to a sodium sulfate type water in the lowlands. Surface water quality in the Project Area is affected by depletions and return flows from irrigation. Surface water withdrawals in the Project Area are used to support agricultural, domestic, and stock water uses. Irrigation use accounts for about 98 percent of the surface water withdrawals in the Project Area.

Characteristics of River Basins and Surface Drainage Systems

The Project Area is divided into 18 sub-watersheds. The sub-watersheds in the Project Area comprise two distinct hydrologic regions: the mountainous region, where snowmelt has a dominant influence on streamflows and the plains region, where runoff from convective storms has a significant influence on peak flows (Lowham 1988). In the mountainous region, headwaters of the streams are situated in mountains and foothills, at elevations ranging from 6,000 to 13,000 feet above mean sea level (msl). Annual precipitation ranges from 14 to 25 inches, mostly from snow (Lindner-Lunsford et al. 1992). Streams are cascading, with relatively steep slopes. Concentrations of suspended sediments and dissolved solids are lower in mountain streams overlying older geological formations, and increase significantly as the streams flow toward lower elevations. Streamflows originating in the mountainous region are perennial. Annual runoff typically exceeds 0.3 cubic feet per square mile (Hodson et al. 1973).

Figure 3–2 Water Well Density and Existing CBM Wells

In the plains region, streams are situated in plains, tablelands, badlands, and open high hills, at elevations ranging from 3,000 to 6,000 feet above msl. Annual precipitation ranges from 10 to 14 inches (Lindner-Lunsford et al. 1992). Streams are meandering, with relatively flat slopes. Concentrations of suspended sediments and dissolved solids are higher than in the mountain streams, due to contact with younger geologic formations and disturbance from human activities in the lower elevations. Streams originating in the plains and desert areas generally are ephemeral, flowing mainly in direct response to rainstorms and snowmelt (Lowham 1988). Annual runoff is generally less than 0.05 cubic feet per square mile (Hodson et al. 1973).

Within these two regions, each sub-watershed in the Project Area has a unique combination of water quantity, quality, and existing water use.

Surface Water Quantity

Major contributions to streamflows in the Project Area include direct precipitation, surface runoff, and releases from surface reservoirs. Evaporation, evapotranspiration, and infiltration cause decreases in streamflow. These components are described below.

For the purposes of this discussion, surface water flow is expressed in cfs. The water produced from wells is expressed in gpm. One cfs is equivalent to 448.83 gpm. Large flows or volumes of water are expressed as acre-feet. One acre-foot is equivalent to 43,560 cubic feet, or 325,851 gallons. Large volumes of produced water also are expressed as barrels (Bbls) or thousand barrel units (MBbls). There are 42 gallons in one barrel.

Natural Streamflow

Streamflow characteristics depend upon the specific features unique to each drainage basin. These features include geology, topography, vegetative cover, size, and climate. Most of the streams in the Project Area are ephemeral, flowing only in response to snowmelt or precipitation events. The major perennial streams and tributaries in the Project Area experience their highest flows during May, June, and July. Peak flows are the result of melting snow that accumulates in the higher elevations from October to April. The lowest flows occur during the winter months.

Mean annual flow data have been compiled from selected USGS stream gaging stations to provide a perspective of perennial stream flow within the Project Area. This information is summarized in Table 3–5. Flows range from minimal in the Dry Fork of the Cheyenne River, to 1,282 cfs in the Middle North Platte River. For the period of record 1931 to 1999, the Upper Powder River at Arvada averaged an annual flow of 281 cfs. The Upper Belle Fourche River below Moorcroft averaged an annual flow of 24.6 cfs for the period of record 1944 to 1999. The highest mean annual flow of 1,282 cfs was measured in the Middle North Platte River near Alcova for the period of record 1905 to 1998. Flows in the Project Area are influenced by irrigation diversions and releases from storage reservoirs.

Table 3–5 Annual Flow Statistics at Selected USGS Gaging Stations in the Powder River Basin

Sub-Watershed	Drainage Area (mi^2)	Station Location	Station ID	Mean (cfs)	Min (cfs)	Max (cfs)	Period of Record
Little Bighorn River	428	L Bighorn R bl Pass Cr nr Wyola, MT	06290500	204	95	390	1940-1999
Upper Tongue River	1,477	Tongue R @ State Line nr Decker, MT	06306300	463	209	872	1961-1999
Middle Fork Powder River	45.2	Middle Fork Powder R nr Barnum, WY	06309200	30.6	13.2	50.5	1961-1999
North Fork Powder River	803	Nowood R nr Ten Sleep, WY	06270000	112	57.1	258	1953-1955 1973-1991
Upper Powder River	6,050	Powder R at Arvada, WY	06317000	281	90.4	744	1931-1999
South Fork Powder River	1,150	South Fork Power R nr Kaycee, WY	06313000	37.2	14.4	119	1939-1979
Salt Creek	769	Salt Creek nr Sussex, WY	06313400	44.4	22.8	81.9	1977-1992
Crazy Woman Creek	945	Crazy Woman Creek at Upper Sta, nr Arvada, WY	06316400	56.7	11.7	125	1964-1980
Clear Creek	1,110	Clear Creek nr Arvada, WY	06324000	181	49	404	1916-1981
Middle Powder River	8,088	Powder R at Moorhead, MT	06324500	465	136	1,093	1929-2000
Little Powder River	1,235	L Powder R Ab Dry C nr Weston, WY	06324970	22.9	1.5	125	1972-1999
Little Missouri River	904	L Missouri R nr Alzada, MT	06334000	61.8	3.0	323	1913-1968
Antelope Creek	1,030	Antelope C nr Teckla, WY	06364700	12.6	2.0	28.7	1978-1980
Dry Fork Cheyenne River	128	Dry Fork Cheyenne R nr Bill, WY	06365300	1.0	0.2	3.5	1977-1986
Upper Cheyenne River	5,270	Cheyenne River nr Riverview, WY	06386500	60	6	283	1949-1973
Lightning Creek	2,070	Lance Creek nr Riverview, WY	06386000	26.5	2.5	87.4	1949-1982
Upper Belle Fourche River	1,690	Belle Fourche R bl Moorcroft, WY	06426500	24.6	1.1	135	1944-1999
Middle North Platte River	10,812	North Platte R at Alcova, WY	06642000	1,282	662	2,604	1905-1998

Source: USGS 2001c

Peak Flow/Stormwater Flow

Peak flows in the Project Area occurred in May 1978, when the region experienced a flood of one percent probability, or a flood that occurs once every 100 years (Parrett et al. 1984). Peak flows during this event in the Little Powder River, Middle Powder River, and Upper Belle Fourche River measured 5,300 cfs, 33,000 cfs, and 15,300 cfs, respectively.

Stormflows have been estimated for each sub-watershed in the Project Area using the basin characteristics methodology as outlined by Lowham (1988). This information is summarized in Table 3–6.

Evaporation

Evaporation losses in the Project Area occur from water surfaces, such as reservoirs and stream channels. Throughout the Project Area, annual lake evaporation averages from 39 to 45 inches, greatly exceeding annual precipitation (Whitehead 1996). Pan evaporation rates in the Project Area are as much as 60 inches per year. Evaporation data are typically only collected during periods of warm weather, or seasonally. The highest evaporation rates generally occur during the summer months of June, July, and August and typically decrease during the winter months. Evaporation is large during periods of intense solar radiation, low relative humidity, and rapid wind movement (Taylor 1978).

Evapotranspiration (ET) measurements include evaporation from water and soil surfaces and the transpiration from plants. Lowry et al (1986) describe ET rates highest during the month of July, but still significant over the fall months due to warm soil temperatures. Rankl and Lowry (1990) compare ET rates with the growing season for vegetation. During the growing season, April through September, ET is greatest. From October through March, which approximates the dormant period of vegetation, ET rates are lower. Miller (1981) calculated potential ET rates for the Powder River Basin in southeastern Montana, which range from 24 to 41 inches per year. This is considerably greater than the average annual precipitation of 16 inches for the area, except for extremely wet years.

Table 3–6 Predicted Stormflows by Sub-watershed within the Powder River Basin

		Flow (cfs)					
Sub-Watershed	Watershed Area (mi^2)	2-year 24-hour	5-year 24- hour	10-year 24-hour	25-year 24- hour	50-year 24-hour	100-year 24-hour
Little Bighorn River	1,275	3,008	5,042	6,678	9,486	12,355	14,851
Upper Tongue River	2,547	4,037	6,807	8,937	12,496	16,022	18,910
Middle Fork Powder River	992	2,309	3,904	5,050	6,931	8,686	10,164
North Fork Powder River	1,994	4,432	7,158	9,074	12,177	15,116	17,383
Upper Powder River	2,497	3,560	6,140	8,185	11,651	15,128	18,065
South Fork Powder River	1,219	2,300	4,018	5,318	7,475	9,538	11,299
Salt Creek	807	1,476	2,651	3,577	5,134	6,637	7,987
Crazy Woman Creek	962	1,787	3,155	4,217	5,992	7,704	9,207
Clear Creek	1,149	2,384	4,020	5,243	7,257	9,182	10,800
Middle Powder River	1,067	1,712	2,915	3,899	5,604	7,340	8,935
Little Powder River	2,033	3,007	5,042	6,678	9,486	12,355	14,851
Little Missouri River	3,440	4,714	7,610	9,929	13,938	18,141	21,706
Antelope Creek	1,051	1,959	3,398	4,514	6,379	8,187	9,762
Dry Fork Cheyenne River	492	917	1,694	2,322	3,391	4,423	5,393
Upper Cheyenne River	1,435	2,269	3,937	5,272	7,541	9,804	11,793
Lightning Creek	1,014	1,810	3,156	4,217	6,006	7,757	9,306
Upper Belle Fourche River	2,940	5,311	8,347	10,621	14,401	18,183	21,151
Middle North Platte River	3,490	5,959	9,966	12,864	17,621	22,210	25,748

Source: Lowham 1988

Infiltration

Infiltration and seepage losses into underlying alluvium and geologic substrates occur along stream channels and reservoirs in the Project Area.

Meyer (2000) analyzed CBM water production and streamflow data for a portion of the Belle Fourche River basin during the months of May through September. The analysis indicated that little or none of the water discharged as a result of CBM operations reached the stream gaging locations. During periods of little or no precipitation, conveyance losses due to ET and infiltration may be greater than 90 percent (Meyer 2000). Similar trends were noted by Meyer in the Little Powder River drainage. Meyer concludes that “water production volumes are not as great as estimated in the Wyodak EIS (BLM 1999c) and streamflow conveyance losses have been significantly greater than predicted.”

AHA conducted conveyance loss studies on representative drainages receiving CBM produced water discharges in the Project Area. These studies were conducted during October 2000 when ET rates are typically minimal and conveyance losses from stream channels and reservoirs are primarily due to infiltration.

Results indicated infiltration of about 80 percent, on average, with infiltration as high as 99 percent in selected drainages (AHA 2001b).

CBM Produced Water

Produced water from CBM wells is currently gathered and discharged to the surface at outfall locations permitted by the WDEQ after the issuance of a National Pollutant Discharge Elimination System (NPDES) permit.

In portions of the Project Area, produced water from existing CBM development is supplementing stream flows or wetting otherwise dry channels year-round for some stream channel length or segment below the surface discharge points.

Discharge Outfalls

A search of the State of Wyoming's NPDES database reveals 696 existing point source discharge permits within the Project Area, corresponding to 3,975 permitted outfalls (WDEQ 2001). Permitted outfalls from CBM facilities comprise 94 percent of the total, followed by coal mining facilities (4 percent), and oil treater facilities (1.5 percent). The permitted outfalls for CBM facilities within the Project Area are summarized on Table 3–7, and illustrated on Figure 3–3. Almost 50 percent of the CBM outfalls are located within the Upper Belle Fourche River sub-watershed. The majority of the remaining CBM outfalls are distributed in the Upper Powder River sub-watershed (21 percent), and the Little Powder River sub-watershed (14 percent).

Table 3–7 Permitted Outfalls for CBM Discharges in the Powder River Basin

Sub-watershed	# CBM Discharge Permits	# CBM Dishcarge Outfalls	Year 2000 CBM Discharges[1] (cfs)	Average Discharge per Outfall (cfs)
Upper Tongue River	18	122	1.77	0.0096
Upper Powder River	129	790	7.61	0.0096
Clear Creek	13	48	0.008	0.0002
Middle Powder River	28	139	1.35	0.0097
Little Powder River	97	533	11.9	0.022
Antelope Creek	49	171	0.32	0.002
Upper Cheyenne River	32	175	8.63	0.049
Upper Belle Fourche River	240	1,766	35.7	0.020
Total	606	3,744	67.3	0.015

Source: WDEQ 2001
1 Calculated from Table 3–3.

Discharge Volumes/Flow

On average, point source discharges from existing CBM operations in the Project Area range from 0.0002 to 0.049 cfs, or about 1 to 25 gpm, at each discharge outfall. As stated previously, these flows are reduced by conveyance losses in the stream channels and minimal or no discharged water is reaching the main stems. Most of the discharges are occurring in the Upper Belle Fourche River, Upper Powder River, Middle Powder River, and Little Powder River sub-watersheds.

Figure 3–3 Outfall Density, Water Production, and USGS Gaging Stations

Surface Water Quality

The chemical composition of surface water changes continually. Most changes are related to the amount of water and the source of water flowing in a stream at a given time. Surface water quality is directly influenced by higher amounts of precipitation associated with the mountainous regions and the composition of rocks in the area. Streamflows resulting from snowmelt and precipitation are in contact with soils and rocks for only a limited time; thus, these waters have only small amounts of dissolved minerals. Surface water type also changes with elevation. Streams in the higher elevations are typically calcium bicarbonate type waters. As the streams flow across the lowlands, both as natural flow and irrigation return flow, they change to sodium sulfate type waters. The waters are typically alkaline and have moderate to high levels of hardness.

Ambient Water Quality

Surface water quality data for inorganic chemical constituents and trace metals from the Project Area are summarized in Appendix E. Selected surface water quality monitoring stations in the Project Area are illustrated on Figure 3–3. Water quality in various stream segments within the Project Area is affected by irrigation return flows, runoff from erosive soils, and other natural background conditions. General surface water quality conditions in the Project Area are discussed below.

Metals

Concentrations of trace metals in surface waters draining the Project Area are generally low. Levels of iron and manganese that exceed the secondary drinking water standards of 0.3 mg/L and 0.05 mg/L, respectively, have been detected in surface water in the Project Area occasionally. Manganese and iron can cause staining and bitter tastes, but are not present in concentrations that would limit use of the water for stock watering or irrigation. Of samples collected at the water quality monitoring stations identified in Appendix E, average manganese concentrations ranged from less than detectable to 2.1 mg/L. Average iron concentrations ranged from less than detectable to 0.2 mg/L.

Concentrations of selenium greater than the drinking water standard of 10 micrograms per liter (µg/L) have been measured in surface water from localized streams in the Project Area (Lowry et al. 1986). Most of the high selenium values have been detected in the South Fork of the Powder River near Kaycee. Over the period 1949 to 1994, the average selenium value at this location was 17 µg/L (USGS 2001c). Selenium sources within this sub-watershed are geologic in their origin (Seiler et al. 1999). Although selenium concentrations exceed the drinking water standard, the stream is not used as a public water supply (USEPA 2001). Selenium concentrations do not limit the use of the water for stock watering, however, due to uptake of selenium, certain vegetation could become toxic to livestock. Selenium concentrations greater than 2 to 5 µg/L can cause reproductive failure in fish and wildlife (U.S. Department of the Interior 1987).

Dissolved Solids

TDS represents the sum of all dissolved constituents in a water sample, and therefore, is often used as an overall indicator of water quality. Concentrations of

TDS typically are lower in streams at high elevation and increase significantly as streams flow away from the mountains.

In most of the Project Area, concentrations of TDS typically exceed the secondary drinking water standard of 500 mg/L. Nearly 50 percent of the TDS concentrations measured at water quality monitoring stations in the Project Area are greater than 2,000 mg/L (Lowry et al. 1986). In the southwest portion of the Project Area, average TDS concentrations range from 566 mg/L in the North Fork of the Powder River to 2,660 mg/L in the South Fork of the Powder River. In the central portion of the Project Area, stations in the Middle Powder River and Upper Powder River sub-watersheds report average TDS concentrations of 1,389 and 1,888 mg/L, respectively. On the eastern side of the Project Area, TDS measurements in the Dry Fork of the Cheyenne River average 1,375 mg/L, and are slightly higher in the Upper Cheyenne River, with an average TDS concentration of 2,109 mg/L. The Upper Belle Fourche River in the northern portion of the Project Area averages 1,718 mg/L TDS.

Suspended Sediment

Concentrations of suspended sediment are high throughout the Project Area. Concentrations reflect the highly erosive nature of the shale deposits through which the rivers flow. Sediment concentrations increase in a direct relationship to flow. In the Project Area, suspended sediment concentrations averaging 695 mg/L are reported in the Upper Belle Fourche River. Concentrations are significantly higher in the Upper Powder River, where average suspended sediment concentrations range from 14, 400 mg/L to 19,095 mg/L.

Sodium Adsorption Ratio

Sodium adsorption ratio (SAR) represents the proportion of sodium ions to calcium and magnesium ions in water. SAR is an indicator of the potential for water to impact soil structure. Surface waters having SAR values of 10 to 15 and greater used for irrigation pose a potential hazard to the health of individual plants growing in the irrigated soils, and thus, to the productivity/yield of the irrigated cropland. The application of irrigation waters with high SAR values results in a disproportionate concentration of sodium adsorbed by the soil at the expense of calcium and magnesium, which alters the physical condition of the soil growth medium. The sodium imbalance causes soil structure to breakdown and the soil particles to disperse. This is particularly true with clayey soils.

Average SAR values in the Project Area have ranged from <1 to 31.7. The highest SAR value was reported in Salt Creek, near Sussex. In the Upper Powder River, average SAR values have ranged from 4.8 to 6.3. Measurements in the Upper Belle Fourche River and the Little Powder River are similar, ranging from 5.1 to 6.1, and 5.9 to 6.1, respectively. Average SAR values in Clear Creek range from 1.1 to 1.4.

Temperature

The temperature of water in streams within the Project Area can range from 0 degrees Celsius (C) during winter to 25°C or more during late summer (Lowry et al. 1986). Water temperatures in streams also vary as a function of elevation. Historically, water temperature measurements in the Project Area have ranged from

4.2 to 17.0°C (USGS 2001c). For the period of record from 1946 to 2000, mean water temperatures ranged from 9.6 to 11.6°C in the Upper Powder River at Arvada. For the period of record from 1972 to 2000, mean values ranged from 8.7 to 10.8°C in the Upper Belle Fourche River below Moorcroft. The highest mean water temperature (17°C) in the Project Area was measured in the South Fork of the Powder River near Kaycee (USGS 2001c).

Impaired Water Bodies

The quality of water in the rivers and streams within the Project Area is protected for designated uses in accordance with the State of Wyoming's water quality standards. The State of Wyoming's 305(b) Report for 2000 lists waterbodies with water quality impairments in the Tongue River, Upper Powder River, Upper Belle Fourche River, and the Middle North Platte River sub-watersheds (WDEQ 2000). Listed impairments are caused primarily by pathogens; trace metals, specifically selenium and arsenic; chloride; TDS; and salinity. Most sources of the impairments are unknown.

A segment of the Powder River below Salt Creek is impaired as a Class 2 warm water fishery (2WW) by selenium and chloride. Certain waterbodies in the North Platte River basin are impaired for use by wildlife and for agriculture. The Kendrick Reclamation Project removes water from Seminoe and Alcova Reservoirs for irrigation use northwest of Casper. However, much of the irrigated soil contains naturally high levels of selenium, which is readily dissolved and transported by the irrigation water. Studies performed by the USGS have determined that irrigation return flows contain high levels of selenium, which result in selenium loading into the North Platte River and several streams, wetlands, and reservoirs near the reclamation project (Sieler et al. 1999).

Waterbodies delisted from the State of Wyoming's 1998 303(d) list include a segment of the Upper Belle Fourche River below the Hulett Wastewater Treatment Plant (WWTP), and a segment of the Tongue River below the Forest Service WWTP. These delistings resulted from the establishment of Total Maximum Daily Load's (TMDLs) for ammonia, residual chlorine, and fecal coliform (WDEQ 2000).

Surface Water Distribution

The distribution of surface water flows in the Project Area is influenced by natural streamflow, CBM produced water discharges, and releases from reservoirs.

Streamflows

About 80 percent of the streams in the Project Area are ephemeral and interrupted streams. Major perennial streams in the Project Area include the Upper Tongue River, Upper Powder River, Middle Powder River, Little Powder River, Clear Creek, and Crazy Woman Creek.

CBM Produced Water

The distribution of existing surface water flows are influenced by CBM produced water discharges, depending on the volume of water produced and how the water is handled. Sub-watersheds with high volumes of CBM water production, such as the Upper Belle Fourche River, Little Powder River, and Upper Powder River sub-watersheds, exhibit more continuity in flows than sub-watersheds with limited CBM development. Water handling also influences the distribution of surface flows. Direct discharges of CBM produced water into surface drainages have a greater influence on surface flows than surface discharge into flow-through stock reservoirs or infiltration impoundments.

Reservoir Outflows

Reservoirs in the Project Area are used to hold water supplied from snowmelt, and to make stored water available during summer and fall, periods of limited precipitation and heavy demand. Major reservoirs receiving potential CBM produced water discharges in or downstream of the Project Area include Keyhole Reservoir in the Upper Belle Fourche River sub-watershed, Lake DeSmet, an off-channel reservoir, in the Clear Creek sub-watershed, and Angostura Reservoir in the Upper Cheyenne River sub-watershed. The storage capacities of these three reservoirs are 340,000 acre-feet, 239,000 acre-feet, and 103,431 acre-feet, respectively. Annual releases to the Belle Fourche River from Keyhole Reservoir average about 16,000 acre-feet. Numerous small reservoirs and stock reservoirs also exist in the Project Area.

Surface Water Use

Surface water withdrawals in the Project Area totaled 1,636 million gallons per day (mgd) in 1995. Table 3–8 summarizes water use within the PRB in 1995 (USGS 1995). Nearly 35 percent of the surface water withdrawals were from the Upper Tongue River sub-watershed. Surface water consumption in the Project Area is predominantly associated with irrigation use. About 98 percent of the surface water withdrawals (1,602 mgd) are used for irrigation. Nearly 72 percent of the irrigation occurs in the Upper Tongue River, North Fork of the Powder River, Upper Powder River, and Clear Creek sub-watersheds. Mining use accounts for only one percent, or 18.26 mgd of the total surface water withdrawals. About 47,130 people living in the Project Area obtained their water supply from surface water sources in 1995, consuming 11.75 mgd, or about one percent of the surface water withdrawals (USGS 1995).

Permitted Water Diversions/Structures

Surface water adjudication rights in the Project Area are summarized in Table 3–9. Of the 78,316 filings of surface water adjudications, 57 percent are used for irrigation. About 20 percent are used for domestic purposes. The remaining 23 percent of the surface water adjudications in the PRB are used for stock watering and other purposes. The adjudication does not necessarily mean that all of the water is available every year for the intended use, but reflects legal claims on the water. Permitted reservoirs and stock reservoirs in the Project Area are summarized in Table 3–10.

Municipal Water Sources

Communities in the Project Area utilizing surface water as a municipal water supply include the City of Sheridan, and the towns of Buffalo, Dayton, and Ranchester (USEPA 2001). Surface water sources in the Tongue River sub-watershed supply the communities of Sheridan, Dayton and Ranchester. Buffalo utilizes surface water from the Clear Creek sub-watershed. Surface water withdrawals for municipal water supplies account for about one percent of the total surface water use in the Project Area. The majority of municipal water supplies in the Project Area are acquired mainly from groundwater sources.

Table 3–8 1995 Surface Water Use within the Powder River Basin

	Water Use by Category (mgd)						
Sub-watershed	Public Supply	Commercial	Domestic	Industrial	Mining	Livestock	Irrigation
Little Bighorn River	0.00	0.00	0.00	0.00	0.00	0.11	90.66
Upper Tongue River	5.37	0.02	0.00	0.01	0.03	0.7	526.72
Middle Fork Powder River	0.00	0.01	0.00	0.00	0.21	0.13	70.54
North Fork Powder River	0.00	0.00	0.00	0.00	0.28	0.33	276.27
Upper Powder River	0.00	0.00	0.00	0.00	0.52	0.27	134.4
South Fork Powder River	0.00	0.00	0.00	0.00	0.71	0.19	43.98
Salt Creek	0.39	0.01	0.00	0.00	0.38	0.11	28.21
Crazy Woman Creek	0.00	0.00	0.00	0.00	0.09	0.09	63.04
Clear Creek	1.26	0.02	0.04	0.00	0.08	0.29	215.44
Middle Powder River	0.00	0.00	0.00	0.00	0.12	0.04	14.4
Little Powder River	0.00	0.00	0.00	0.00	2.65	0.1	0.39
Little Missouri River	0.00	0.00	0.00	0.00	0.37	0.15	8.56
Antelope Creek	0.00	0.00	0.00	0.00	1.78	0.11	6.79
Dry Fork Cheyenne River	0.00	0.00	0.00	0.00	0.15	0.06	5.05
Upper Cheyenne River	0.00	0.00	0.00	0.00	4.31	0.14	2.92
Lightning Creek	0.00	0.00	0.00	0.00	0.2	0.1	6.86
Upper Belle Fouche River	0.00	0.03	0.03	0.02	4.37	0.39	17.3
Middle North Platte River	4.73	0.07	0.02	0.02	1.98	0.53	90.32
Project Area Total	11.75	0.16	0.09	0.05	18.26	3.93	1,601.85

Source: USGS 1995

Table 3–9 Surface Water Adjudications within the Powder River Basin

	Use			
Sub-Watershed	Irrigation	Domestic	Stock	Other
Little Bighorn River	1,120	42	67	39
Upper Tongue River	19,885	8,824	1,728	1,067
Middle Fork Powder River	2,024	423	450	44
North Fork Powder	7	6	24	0
Upper Powder River	2,085	668	1,810	36
South Fork Powder River	196	42	195	21
Salt Creek	4	33	57	6
Crazy Woman Creek	3,508	787	648	501
Clear Creek	10,458	2,032	989	4,091
Middle Powder River	454	47	324	6
Little Powder River	2,299	776	1,534	148
Little Missouri River	85	0	116	0
Antelope Creek	884	158	728	273
Dry Fork Cheyenne River	253	67	384	36
Upper Cheyenne River	53	72	366	151
Lightning Creek	410	7	356	50
Upper Belle Fouche River	954	1,792	1,016	246
Middle North Platte River	136	88	113	17
Project Area Total	44,815	15,864	10,905	6,732

Source: WSEO 2001

Table 3–10 Surface Water Impoundments in the Powder River Basin

Sub-Watershed	# Permitted Reservoirs	Average Capacity (acre-feet)	# Permitted Stock Reservoirs[1]	Average Capacity (acre-feet)
Little Bighorn River	26	55.0	10	9.2
Upper Tongue River	287	32.8	321	4.2
Middle Fork Powder River	30	56.7	68	4.0
North Fork Powder	0		0	
Upper Powder River	162	46.0	345	6.0
South Fork Powder River	13	59.9	20	8.9
Salt Creek	6	44.9	16	3.5
Crazy Woman Creek	116	95.7	86	5.8
Clear Creek	123	36.0	187	5.1
Middle Powder River	17	19.6	63	6.0
Little Powder River	117	50.5	346	4.5
Little Missouri River	11	29.2	24	4.4
Antelope Creek	58	79.3	101	4.6
Dry Fork Cheyenne River	27	60.4	85	5.2
Upper Cheyenne River	19	30.6	49	4.3
Lightning Creek	28	92.6	75	5.6
Upper Belle Fouche River	103	49.2	167	5.3
Middle North Platte River	18	110.0	13	8.1
Project Area Total	1,161	55.8 (Avg)	1,976	5.6 (Avg)

Note:
1. As per WSEO regulations, stock reservoirs limited to 20 acre-feet.
Source: WSEO 2001.

CBM Produced Water Use/Treatment

The primary method currently used for handling the produced water is direct surface discharge through discharge outfalls. Outfalls may feed into small stock reservoirs, constructed infiltration basins, or other facilities before the outflows reach surface drainages. In addition to direct surface discharge, alternate methods of disposing of produced water being utilized, tested, or considered by CBM operators include evaporation enhancement, re-injection, percolation, irrigation, surface containment, and treatment (Western Gas Resources, Inc. 2001). The method of handling the produced water varies with water quality, water volumes, and desires of the surface owners. A discussion of each of these options is included below.

Surface discharge of the produced water represents both direct discharge and discharge retained temporarily in flow-through upland or bottom-land impoundments. These discharges are permitted by the WDEQ after the issuance of an NPDES permit.

Evaporation enhancement utilizes atomizers installed on towers above the ground or on floating platforms in the middle of a reservoir. Atomizers placed aboveground have been successful in managing the volumes of CBM water produced, but due to their limited use, it is unknown what the duration of use would be to avoid build-up of trace elements in the ground beneath the tower. Pilot testing utilizing atomizers placed on floating platforms in the middle of a reservoir has indicated that 50 percent of the CBM water can be eliminated. Build-up of trace elements in the reservoir is purged during heavy runoff periods when the reservoir overflows. This method of water handling is being utilized at multiple locations within the Project Area. Large surface area ponds have been built to enhance evaporation, although this method is less favorable due to the high cost and surface impact.

Re-injection is accomplished by injecting the water into deep disposal wells. Potential injection zones include the sands and coals within the Wasatch and Fort Union Formations. Data are limited regarding the success of this method of water handling. A nine-well injection project was initiated into the Wall Coal, using produced water from the Anderson/Canyon Coal. These wells did receive water for six months; however, injection pressures became so elevated that fracturing became a concern.

A ten-well injection project was initiated into the Fort Union Formation near the City of Gillette. Results of injection were favorable. Since the receiving aquifer had been partially depleted by a multitude of shallow private and municipal water wells, injection could occur at low surface pressures. One operator indicated that this would not be a feasible alternative for water handling in areas where the aquifer is not partially depleted, due to excessive injection pressures.

Percolation of the produced water into scoria formations or other near shallow aquifers is being tested by at least one company. This method of water handling utilizes a trench or narrow pit excavated along a scoria bed, and allows the produced water to percolate from the trench or pit into the scoria bed. Thus far, this method is only being utilized in areas where the scoria bed does not outcrop, due to the potential for seepage.

Infiltration basins are constructed to dispose of the produced water through infiltration into the underlying alluvial or basin fill deposits, clinker, or sandy bedrock horizons. These basins are situated in existing drainages and in upland areas. Infiltration of the produced water can be 30 percent or more. The basins are designed not to discharge infiltrated water back to the surface.

CBM produced water is often suitable for irrigation use. Suitability for irrigation depends upon interaction with soil types, SAR values, salinity values, and types of crops grown. Methods of irrigation include flood irrigation using spreader dikes, and center pivot systems.

Surface containment includes upland impoundments, both lined and unlined, with no direct surface discharge or lateral subsurface movement of water and down-gradient expression in seeps or springs. It is estimated that as much as 95 percent of the produced water in certain areas of the Project Area is being contained in reservoirs. Some operators are working closely with the landowners, U.S. Department of Interior, Fish and Wildlife Service (USFWS), Wyoming Game and Fish Department (WGFD), and other agencies to establish the reservoirs as bird rehabilitation areas. The reservoirs are being constructed incorporating islands providing protective habitat for birds as well as game fish.

Treatment of the produced water is utilized to amend the water quality to meet NPDES standards prior to surface discharge, using a chemical process, a reverse-osmosis process, or a combination of both. Pilot testing using this method of water handling has been performed with varying degrees of success.

Physiography, Geology, Paleontology, and Mineral Resources

Physiography

The PRB is part of the Missouri Plateau of the Great Plains (Trimble 1980). This region is characterized by rolling uplands that have been greatly dissected by tributaries of the Missouri River system. The great continental glaciers never extended into the PRB. The Bighorn Mountains, which are part of the Rocky Mountains, lie just west of the PRB, partially within the westernmost portion of the Project Area. The east slope of this imposing mountain barrier, facing the PRB, is steep and rugged for the most part, and is cut by many deep, narrow canyons (Keefer 1974).

The PRB is a structural basin extending about 220 miles from north to south, and generally less than 95 miles from east to west, that formed at the foot of the Bighorn Mountains. The PRB is bounded on its margins by upturned rocks or mountainous masses rising from the plains. On the east, the PRB is bounded by the Black Hills. On the south, the PRB is bounded by the Casper arch, the Laramie Mountains, and the Hartville Uplift (Macke 1993). To the north and northeast, the terrain of the PRB merges with, and cannot be distinguished from, the remainder of the Missouri Plateau (Keefer 1974).

The PRB consists of a dissected, rolling upland plain, with low to moderate relief, broken by buttes, mesas, hills, and ridges. Extensive areas of open high hills in the northern portion of the Project Area indicate rough, broken terrain where moderate to deep erosion has occurred (Keefer 1974). Erosion-resistant clinker, produced by the natural burning of coal beds in the PRB, caps many hills and ridges within the Project Area with a characteristic broken, red brick or scoria-like rock. Elevations in the Project Area range from 3,350 to 9,250 feet above msl.

The present-day landforms of the semiarid PRB have been shaped mostly by the action of water, even though precipitation is low and evaporation greatly exceeds precipitation. The drainages dissecting the Project Area are incised, typically are ephemeral or intermittent, and do not naturally provide permanent or year-round water sources. Major river valleys have wide, flat floors and broad floodplains. Badlands, such as the Powder River Breaks and Tongue River Breaks, have formed where water has flowed over sloping surfaces of soft, fine-grained materials. Playa lakebeds are relics from wetter periods. Surface springs and seeps are fed by groundwater from shallow aquifers. Drainage catchments and open basins are separated by upland landforms such as hills, ridges, and buttes.

The PRB is drained toward the north and east by the Tongue, Powder, Little Powder, Belle Fourche, and Cheyenne Rivers, which all flow into the Missouri River system. The Project Area forms a low divide among these smaller drainage systems. Northwestern and western portions of the area, generally those areas west of Highway 50 and north of Highway 387, are drained by the north-flowing Powder River, which is tributary to the Yellowstone River of the Missouri River system. A small area within the northwestern portion of the Project Area is drained by the Tongue River, another tributary of the Yellowstone River. The northeastern portion of the Project Area is drained by tributaries of the Little Powder River, which flows into the Powder River. The area east of Highway 50, located between the communities of Gillette and Wright, is drained by the Belle Fourche River and its tributaries. The areas south and east of Highway 387 are drained by the Cheyenne River.

Geology

The PRB is a northwest-southeast trending structural basin filled with Cenozoic sediments of continental origin that were derived from surrounding uplifted areas (Brown 1993). The PRB formed during the Laramide Orogeny (mountain building era) about 60 million years ago (Glass and Blackstone 1996).

Portions of the eastern flank of the Bighorn Mountains also are included within the Project Area. The Paleozoic and Mesozoic rocks exposed along the eastern flank of the Bighorn Mountains, within the westernmost portion of the Project Area, are stratigraphically below and older than the geologic formations that may be affected by CBM development in the PRB, and are not described further.

The PRB was shaped by folding and minor faulting that occurred during the early Tertiary period, and ended before the deposition of the Oligocene White River Formation (Macke 1993). The PRB margins are folded asymmetrically upward along a northwest trending basin axis that is closer to the western margin than it is to the eastern margin. Rock layers dip gently several degrees throughout much of the PRB, however, dips steepen significantly in the western portions of the basin (Macke 1993).

Geologic formations exposed at the surface within the PRB are, from youngest to oldest, the Oligocene White River Formation, the Eocene Wasatch Formation, and the Paleocene Fort Union Formation (Ellis 1989). Outcrops of the geologic formations exposed at the surface within the Project Area can contain significant amphibian and mammalian fossils.

Basin sediments were derived from the Bighorn Mountains to the west, the Laramie Mountains and Hartville Uplift to the south, and the Black Hills to the east. The early Tertiary basin fill sediments of the PRB (Wasatch and Fort Union Formations) attain a maximum thickness of over 6,500 feet along the basin axis (Brown 1993). Along drainages, Quaternary alluvial deposits overlie the Tertiary geologic formations exposed in the PRB.

The Cretaceous Lance Formation, of continental origin, underlies the early Tertiary formations in the PRB (Brown 1993) and is exposed only in the southern and western portions of the Project Area, outside the area where Tertiary coals occur (Ellis 1989). The Lance Formation is stratigraphically below and older than the geologic formations that may be affected by CBM development in the PRB and is not described further. The generalized geology of the PRB is shown in Figure 3–4. Geologic formations occurring in the PRB are shown in Figure 3–5.

Figure 3–4 Generalized Geology of the Powder River Basin

Figure 3–5 Stratigraphic Nomenclature for the Powder River Basin

The natural burning of coal beds in the PRB over the past few million years has consumed billions of tons of coal and has baked and melted the overlying bedrock (see page 3–44). This rock, known as clinker, presently covers about 460 square miles of the Project Area (Heffern and Coates 1997). Clinker rock types vary greatly, depending on lithology of the parent rock, temperature and duration of heating, and degree of oxidation (Coates and Heffern 1999).

Quaternary Alluvial Deposits

Unconsolidated and poorly consolidated Quaternary alluvial deposits have been accumulating over the last several million years (Trimble 1980). These deposits generally occur along rivers and major drainages within the PRB and consist of clay, silt, sand, and gravel occurring as floodplains, stream terraces, and alluvial fans. Alluvial deposits commonly are 30 feet or less thick, but deposits that are 100 feet thick have been measured (Wells 1982).

Oligocene White River Formation

The Oligocene White River Formation has been removed by erosion throughout most of the PRB, and is present in the Project Area only as isolated erosional remnants, such as Pumpkin Buttes in southwestern Campbell County (Lewis and Hotchkiss 1981). It is composed of tuffaceous claystone and siltstone with conglomerate lenses near its base (Love et al. 1987). It dates from the Oligocene epoch of the Tertiary period (24 to 37 million years ago).

Eocene Wasatch Formation

The Eocene Wasatch Formation is of stream origin and consists of alluvial mudstone from overbank flood deposits and sandstone from channel deposits. Minor constituents include coarse conglomerate occurring along the western margin of the PRB, carbonaceous shale, and thick coal beds. Sandstone comprises an estimated one-third of the sequence (Seeland 1992). The northwestern portion of the PRB is underlain at shallow depths by locally thick Wasatch coal beds (Culbertson and Mapel 1976). The Wasatch Formation has a maximum thickness of 1,400 feet where it has not been removed by erosion (Molnia and Pierce 1992).

Paleocene Fort Union Formation

The Paleocene Fort Union Formation, of continental origin, consists of sandstone, siltstone, claystone, and beds containing lignite and sub-bituminous coal formed in stream, lake and swamp environments. Fort Union sediments were deposited by north-flowing braided, meandering streams, and swamps in the basin center, and by alluvial fans at the basin margin (Flores et al. 1999). Numerous thick and laterally widespread coal beds occur within the Fort Union Formation (Lewis and Hotchkiss 1981). Goolsby and Finley (2000) suggest the Fort Union coals were continuously deposited in a migrating depositional center. Flores and Bader (1999) report the thickness of the Fort Union Formation to be as much as 5,200 feet along the basin axis of the western PRB in Wyoming.

The thickness of the Fort Union (Wyodak-Anderson) coal zone varies greatly within the PRB. The Wyodak-Anderson coal zone has a maximum net coal thickness of 284 feet, using coal beds greater than 2.5 feet thick, and the entire zone is more than 600 feet thick in the center of the basin (Ellis 1999). The total thickness of the coal beds in this zone commonly range from 50 to150 feet (Seeland 1992). The coal beds average 25 feet in thickness and contain clastic (non-coal) interbeds ranging from a few feet to 150 feet in thickness (Ellis 1999). The coal beds merge in places into a single bed as much as 200 feet thick (Seeland 1992). The thickness of a single coal seam is less than 20 feet along the western margin of the PRB and in the northern portion of PRB within southeastern Montana (Seeland 1992). The thickness of a single coal seam is more than 100 feet near Wright and extending west and northwest of Wright, within the central portion of the PRB in Wyoming (Seeland 1992).

Regionally, the different coal zones merge, split, and pinch out laterally in complex patterns (Flores 1999, Flores et al. 1999), and can be traced intermittently over distances of several tens of miles (Pierce et al 1990). The coal zone contains up to six coal beds in a given location (Ellis 1999). Flores and Bader (1999) and others have studied the number of coal beds occurring within the Fort Union coal zone in different portions of the PRB. Along the eastern margin and within the south central portion of the Project Area, predominantly one coal bed occurs. Within the north-central and western portions of the Project Area, there are typically three or more coal beds. Within the remaining portions of the Project Area, there are predominantly two coal beds. Important coal beds are described in the coal section of this chapter, under mineral and energy resources. The coal zone nomenclature used in this analysis for groundwater modeling is described later, at the beginning of the groundwater section in Chapter 4.

The Fort Union Formation is subdivided into three members within the central and northern portions of the Project Area. From youngest to oldest, the three members are the Tongue River, Lebo, and Tullock. The Tongue River is the uppermost member and is rich in sandstone and coal. The middle Lebo member has a high percentage of shale, and the lowest Tullock member is dominated by sandstone. Along the western margin of the Project Area, the Fort Union Formation is undifferentiated. East of Gillette and within most southern portions of the Project Area, the Tongue River and Lebo members are mapped together as one unit (Ellis 1989).

The Tongue River member is of composed of thick channel sandstones, fine-grained overbank deposits, and coal beds. This unit thins toward the southeastern portion of the PRB (Pierce et al. 1990). The Tongue River member was formed during episodes of high-energy stream activity having intervening periods of quiet activity that led to the accumulation of thick peat deposits in swamps (Pierce et al. 1990). The maximum thickness of the Tongue River member is over 2,100 feet near the basin axis in the central portion of the Project Area. The Tongue River member thins toward the east, and is only 1,000 feet thick north of Gillette (Molnia and Pierce 1992). Flores and Bader (1999) report the thickness of the Tongue River member to be as much as 1,800 feet.

The Lebo member is of stream and lake origin and consists primarily of fine-grained deposits and some channel sandstones (Pierce et al 1990). It is characterized by dark shales containing discontinuous zones of white calcareous banding (paleosol horizons). In the northern PRB the Lebo contains rare beds of gray sandstone as much as 10 feet thick. In the southern PRB some coal beds, a few thicker than two feet, occur within the Lebo and form clinker horizons. The Lebo member ranges in thickness from about 500 feet in the northwestern portions of the PRB to about 1,700 feet in the southwestern portions of the PRB (Brown 1993). The Lebo member thins toward the southeastern portion of the Project Area (Pierce et al 1990). Flores and Bader (1999) report the thickness of the Lebo member to be as much as 2,600 feet.

The Tullock member contains alluvial sediments deposited in a stream environment. It consists of fine-grained sandstone, sandy siltstone, shale, rare thin limestone, and coal. An estimated one-third of the sequence is comprised of channel sandstones. An estimated two-thirds of the sequence is comprised of fine-grained overbank deposits containing thin coal beds. Tullock sediments have a maximum thickness of about 370 feet in the north and 1,440 feet in the south (Brown 1993). Tullock sediments are thickest in the southeastern and western portions of the PRB. Flores and Bader (1999) report the thickness of the Tullock member to be as much as 740 feet.

Paleontologic Resources

Scientifically significant paleontologic resources, including vertebrate, invertebrate, plant, and trace fossils, are known to occur in many of the geologic formations within the Project Area. These fossils are documented in the scientific literature, in museum records, and are known by paleontologists and land managers familiar with the area.

The paleontologic potential of the Project Area was evaluated using the Probable Fossil Yield Classification (PFYC) developed by the FS, which is also employed by the BLM. The classifications include:

- Class 1: Igneous and metamorphic geologic units (excluding tuffs) that are not likely to contain recognizable fossil remains.
- Class 2: Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically significant nonvertebrate fossils.
- Class 3: Fossiliferous sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence.
- Class 4: Class 4 geologic units are Class 5 units that have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation. Proposed ground-disturbing activities would require assessment to determine whether significant paleontologic resources occur in the area of a proposed action and whether the action would impact the resources.
- Class 5: Highly fossiliferous geologic units that regularly and predictably produce vertebrate fossils and/or scientifically significant nonvertebrate fossils and that are at high risk of natural degradation and/or human-caused adverse impacts.

The Project Area contains 34 mapped geologic units (Flores 2001, Love 1985, Love et al. 1987). Of these, one is classified as Class 1, two are classified as Class 2, 27 are classified as Class 3, none are classified as Class 4, and four are classified as Class 5. The four units classified as Class 5 are the Morrison Formation, Lance Formation, Wasatch Formation, and White River Formation.

Most of the geologic units within the Project Area are located around the margins of the PRB and are relatively limited in their distribution. The most widely distributed units are the Wasatch Formation and Fort Union Formation, both of which are discussed below. Within the Project Area, the highly fossiliferous White River Formation (Class 5) occurs only on Pumpkin Buttes in southwestern Campbell County.

The Wasatch Formation (Class 5) is by far the most geographically widespread formation in the Project Area and is the bedrock geologic formation in most of the PRB in Wyoming (Murphey et al. 2001). Because they are mostly vegetated, the formations within the PRB have historically not been perceived to be as rich in fossils as nearby basins, such as the Bighorn and Wind River, which have extensive badland exposures. Nevertheless, the ubiquitous anthills in the PRB contain locally abundant remains of small animals (mouse to rabbit sized), which can be successfully sampled even in vegetated areas.

Murphey et al. (2001) determined no institution has collected articulated bones from the lower Eocene part of the Wasatch Formation in the PRB. The Eocene fossils consist primarily of isolated teeth, with more complete dentary/maxillary fragments comprising approximately 10 percent of total the total number of specimens in the Univeristy of Colorado Museum’s collections. Articulated material, particularly a partial skeleton of the aberrant reptile *Champsosaurus gigas*, is known from older deposits of the Wasatch Formation. Such finds are very rare and appear to be restricted to the Paleocene part of the formation. The Wasatch Formation fossil localities include 106 localities recorded at the University of Colorado Museum, 4 localities recorded at the University of Wyoming Museum of Geology, and 46 localities listed in Delson (1971), who was collecting for the American Museum of Natural History. These localities were originally documented by Wood (Delson 1971).

The Fort Union Formation (Class 3) is not as widely distributed as the Wasatch Formation, but does occur around the margins of the PRB. This formation contains locally abundant fossil vertebrates, invertebrates, and plants, and samples an important time interval during the early Tertiary evolution of mammals. No Fort Union Formation localities from within the Project Area were identified during the museum record search for this analysis, but they do occur nearby in Montana.

Other fossil localities within the Project Area occur in the Mesaverde, Mowry, White River, and Gros Ventre Formations. Fossil localities from outside the Project Area from formations that exist within the Project Area were also identified during this analysis. This locality data were; however, utilized in the class designations recommended for each formation.

It should be emphasized that the lack of localities from any of the geologic units in the Project Area does not mean that no scientifically significant fossils are present. Much of the area within and surrounding the PRB in Wyoming has not been adequately explored for paleontologic resources and new scientifically significant fossil occurrences are being discovered regularly.

Mineral and Energy Resources

The Project Area is one of the major mineral development areas in North America. Coal, oil, gas, and uranium have been the principal mineral and energy resources extracted from the PRB.

Coal

The PRB contains some of the largest accumulations of low sulfur subbituminous coal in the world. Thick coal deposits occur at or near the surface along the eastern boundary of the Project Area, along a north-south trend situated west of both Gillette and Wright, and in the northwestern portion of the Project Area. Coal occurs at depth, below the surface, throughout most of the remainder of the Project Area. Coal from the PRB in Wyoming is valued for its clean-burning properties.

Glass (1997) describes important coal seams of the Powder River Coal Field in Wyoming. These descriptions are summarized in the following paragraphs. Important coal seams within the Wasatch Formation, from oldest to youngest, include the School, Badger, Felix, and Lake De Smet coals. Important coal seams within the Fort Union Formation, from oldest to youngest, include the Canyon, Anderson, Wyodak, and Big George coals.

The School and Badger coals within the Wasatch Formation are developed in the Dave Johnston deposit in the southern part of the PRB. The Felix coal is a persistent coal bed in the northern and central portions of the Project Area, and varies between 5 and 20 feet thick, up to 50 feet thick in the central and southern portions of Campbell County. Felix coal exposures located east of the Powder River in southern Campbell County have been burned (Coates and Heffern 1999). The Felix coal is not currently mined.

The Lake De Smet coal is the thickest known coal seam in the contiguous U.S. Although limited in areal extent, in the northwestern portion of the Project Area the Lake De Smet coal attains a thickness of 250 feet. The Lake De Smet coal is not currently mined, and the uppermost portions of this coal bed are burned over much of its area of occurrence.

The Canyon coal of the Fort Union Formation is a persistent 10 to 65 feet thick coal bed over most of the Project Area. It is correlative with the Monarch coal in the Sheridan area. The Anderson coal is well developed throughout most of the Project Area, and coalesces with the Canyon coal in the Gillette area to form the thick Wyodak coal, which is 25 to 190 feet thick, and averages 100 feet thick. The Wyodak coal has the largest strippable reserve base of any coal bed in Wyoming. In 2000, twelve surface coal mines located in Campbell and Converse Counties produced 323 million tons of coal from the Wyodak coal zone. The mines are located near the eastern boundary of the Study Area, near the outcrop of the Wyodak coal (Figure 2–1 and Figure 3–4), where the overburden thickness is lowest. Extensive clinker deposits exist east of many of the coal mines, which resulted form the spontaneous burning of the Wyodak coal near its outcrop.

Westward from Gillette the Wyodak coal splits into an Upper Wyodak coal comprised of the Anderson and Canyon coals, and a lower, less persistent, Lower

Wyodak coal. North of Gillette the Wyodak coal splits into an Upper Wyodak coal (including the Anderson coal) and a Lower Wyodak coal (including the Canyon coal). Farther west in the vicinity of the Campbell and Johnson county line, the Upper Wyodak coal thickens and becomes the Big George coal. However, in areas southwest of Gillette, both the Wyodak and the Big George coals are present, with the Big George coal zone positioned stratigraphically above the Wyodak coal zone.

The Big George coal is not exposed at the surface. It is reportedly up to 200 feet thick and averages over 100 feet thick. It occurs in the subsurface of the west central portion of the PRB at depths between 1,000 and 2,000 feet, and is not currently mined.

Coal resources in the northwestern portion of the Project Area are summarized by the BLM (1999a). The prominent coal beds within the Tongue River member of the Fort Union Formation are, from oldest to youngest, the Carney, Monarch, Dietz 3, Dietz 2, Dietz 1, Anderson, Smith, and Roland coals. North of Sheridan, underground coal mines operated between 1894 and 1953. Surface mining began in 1944, and continued until 1996. Two active surface coal mines (Decker and Spring Creek) are located northwest of the Project Area in southern Montana.

Most of the coal in the Project Area is federally owned. These federal coal lands are within the Wyoming portion of the decertified Powder River Federal Coal Region (BLM 1999b).

Coal Bed Methane

About 25 trillion cubic feet (tcf) of CBM may be recoverable from coal beds in the PRB within Wyoming (WSGS 2001). For this estimate, data for coals greater than 20 feet thick, occurring deeper than 200 feet below the surface were used, and a recovery factor of 67 percent was assumed.

De Bruin et al. (2001) describe CBM resources occurring in the PRB. CBM is natural gas (methane) occurring in coal beds. In the PRB, CBM was formed as buried plant material was subjected to bacterial activity during coalification (conversion to coal). CBM in the Powder River Coal Field is composed almost entirely of methane (CH_4), with minor amounts of carbon dioxide (CO_2), about 1.5 to 2.0 percent.

A large percentage of the CBM generated during coalification escapes to the surface or migrates into nearby rocks, but a portion is trapped within the coal beds (De Bruin and Lyman 1999). Gas is trapped and stored in coal beds in one of four ways: 1) as free gas in tiny pores or cleats (fractures) within the coal; 2) as dissolved gas in water within the coal; 3) as adsorbed gas on coal surfaces; or 4) as absorbed gas within coal molecules (De Bruin et al. 2001).

While it has been known for many years that methane often vents from shallow water wells and coal exploration drill holes in the PRB, drilling for CBM began in 1986 (De Bruin and Lyman 1999). The first economic production of CBM from the PRB occurred in the Rawhide Butte field just north of Gillette, where production began in 1989 (De Bruin and Lyman 1999, Sawyer and Jeffries

1999). CBM development has been expanding rapidly since 1993 (Flores et al. 2001) and began accelerating in 1997 (De Bruin et al. 2001).

Historical CBM development in the PRB is summarized by Flores et al. (2001). During 1976 to 1996, 1,169 CBM wells were drilled. CBM drilling during 1997 to 1999 increased dramatically to 4,379 wells. During 2000 CBM development activity exploded and 3,831 wells were drilled. About 4,000 CBM wells were producing as of October 2000. From January 1994 through May 2001, CBM production increased at a nominal rate of 65 percent per year.

During 2000 a total of 150,544,625 Mcf of methane and 370,994,154 Bbls of water were produced from PRB coal beds in Wyoming (WOGCC 2001a). By the end of 2001, a total of about 12,077 CBM wells will have been drilled or permitted for drilling in the Project Area. As of November 30, 2000 an estimated 4,093 CBM wells were producing (BLM 2000).

At the time CBM development accelerated in the PRB, Western's MIGC pipeline was the only line out of the basin, and its capacity was filled rapidly (Shirley 2000). De Bruin et al. (2001) describe new gas pipelines in the Project Area. Three major pipelines (large diameter, high pressure gathering lines) were built in the PRB during 1999 and 2000: Bighorn Gas Gathering; Fort Union; and Thunder Creek. Currently CBM flows south out of the PRB on three interstate pipelines and to the north on one interstate pipeline (Sawyer and Jeffries 1999). As of early 2001, nearly 0.5 Bcf of gas per day was being transported out of the PRB (De Bruin et al. 2001).

Oil and Gas

Conventional (non-CBM) oil and gas exploration and production also have occurred for many years within the Wyoming portion of the PRB. Non-CBM oil and gas fields are concentrated within the central, eastern, and southern portions of the Project Area, and the infamous Salt Creek and Teapot Dome oil fields are located on the southwestern shoulder of the PRB (Lageson and Spearing 1991). Wyoming's annual oil production was increasing during the 1950s and 1960s, peaked at nearly 160 million barrels in the early 1970s, and has been declining since then (WOGCC 1998). According to WOGCC production statistics, 336 fields were producing non-CBM oil or gas within the Project Area during 2000 (WOGCC 2001a,c). Nearly 25 million barrels of oil and nearly 60 million Mcf of natural gas were produced from non-CBM PRB fields in Wyoming during 2000 (WOGCC 2001). PRB production comes from a variety of upper and lower Cretaceous strata, as well as from upper Paleozoic strata in the northeastern part of the basin (Lageson and Spearing 1991).

There are currently about 2,546 productive non-CBM wells within the Wyoming portion of the PRB. About 1,347 existing non-CBM wells are federal wells, 1,006 well are fee wells, and 193 wells are state wells (WOGCC 2001c). About 1,282 productive federal non-CBM wells are located in the BLM's Buffalo Field Office Area (BFOA). The number of non-CBM wells abandoned through 2010 is expected to exceed the number of non-CBM wells drilled during that same period (BLM 2001b). From 1985–1999, the WOGCC approved 2,851 permits for non-CBM wells. An estimated 50 percent of the wells permitted (1,397 permits) were federal wells, and around 80 percent of the wells approved were actually drilled (BLM 2001b).

Uranium

Uranium occurs in the southern portion of the PRB, within the Tertiary (Eocene) Wasatch Formation, the Tertiary (Paleocene) Fort Union Formation, and the Cretaceous Lance Formation (Seeland 1976, Raines and Marrs 1983, Lowry et al. 1993). Uranium is present as roll-type deposits within Tertiary fluvial sandstones (Curry 1976). The following uranium districts occur within the PRB: Pumpkin Buttes; Southern Powder River; and Kaycee.

Before near-surface uranium deposits were depleted, 36,787 tons of uranium ore averaging 0.28 percent U_3O_8 were produced by 55 small surface mining operations in the Pumpkin Buttes Mining District of Campbell, Johnson, and Converse Counties during 1953–1967 (Lane et al. 1972, Breckenridge et al. 1974). Numerous prospects and abandoned uranium mines from the 1950s and 1960s remain. Uranium exploration within the PRB peaked during the 1960s and 1970s and substantial reserves were delineated deeper below the surface (Curry 1976).

More recently, uranium has been leached from subsurface deposits located in Converse and Johnson counties. However, the two in-situ leach (ISL) project operations are currently inactive.

Other Minerals

Several geologic materials occurring in the PRB are used as aggregate sources or construction materials. Clinker is produced from burned coal beds, and is widely used as a road surfacing material in the PRB. Clinker occurring in coal beds within the Fort Union Formation covers about 290 square miles of the Project Area. Clinker occurring in coal beds within the Wasatch Formation covers about 170 square miles of the Project Area (Heffern and Coates 1997). Sand and gravel are produced from terrace and alluvial deposits occurring near rivers and larger tributary streams in the PRB. Clay occurring in association with coal in the Fort Union Formation is suitable for use in brick and tile manufacturing, and has been mined in the past (Boyd et al. 1999). No estimate of existing disturbance from aggregate/construction materials quarries in the Project Area is available.

Deposits of bentonite, high-calcium limestone, and gypsum occur in Mesozoic and Paleozoic rocks exposed along the uplifted margins of the Project Area (Wolfbauer 1976, Harris and King 1989). Deposits occurring along the eastern flank of the Bighorn uplift are described by Wendell et al. (1976) and Lageson et al. (1978). These non-metallic industrial minerals are used in various industries, manufacturing, and agriculture for their chemical and physical properties. They occur stratigraphically below the geologic formations that may be affected by CBM development in the PRB.

Production of bentonite comes from surface pits in Cretaceous deposits occurring in south central Johnson County (Wendell et al. 1976). No estimate of existing disturbance from bentonite mining in the Project Area is available.

Geologic Hazards

Earthquake Hazards

The Federal Emergency Management Agency and the USGS have classified Wyoming as having a very high seismic hazard (Wyoming Water Resources Data System [WWRDS] 2001a). Magnitude 6.25 to 6.5 events can occur within the Project Area. However, the Project Area is not within the portion of Wyoming that is included in the high-risk Intermountain Seismic Belt (University of Utah 2001).

Earthquake hazards in Wyoming are summarized by (Wyoming Emergency Management Agency [WEMA] 2001b). Between 1871 and 1993, 69 earthquakes of moderate intensity have originated in Wyoming. The largest recorded earthquake in central and eastern Wyoming occurred near Casper on November 14, 1897. The magnitude of this earthquake was estimated to be between 5.0 and 5.9.

Earthquakes Induced by Injection of CBM Produced Water

Today, underground injection is strictly controlled, and occurs in an injection zone (geological formation) that is sufficiently porous and permeable that fluids can enter the rock formation without causing an excessive build-up of pressure or fracturing of rocks. An earthquake would occur when pressure is released as rocks move in the subsurface.

Underground injection has been regulated by the EPA (and by some states, on behalf of EPA,) only since 1974, when the Safe Water Drinking Act was passed. Prior to 1974 there were inadequate controls on injection wells. Many past examples exist of environmental impacts resulting from fracturing of rock layers or release of built-up pressure, caused by injection.

Flood Hazards

Most surface water in the Project Area flows in response to storm events, snowmelt, releases from reservoirs, or surface discharges of CBM produced water. Flood hazards within the Project Area can be associated with weather conditions such as intense local storm events or rapid snowmelt, CBM discharge into low-capacity stream channels, and the failure or inadequacy of human-engineered drainage or impoundment structures to retain water. Minimization of floods hazards within the Project Area is dependent upon adequate control of surface flows.

Minimization of flood damage from an intense local storm event occurring within the Project Area in 2001 has been attributed to the existence of many small reservoirs storing increased flows of CBM produced water for the beneficial use of landowners (Asssociated Press 2001). A localized storm dumped 7.5 inches of rain near Gillette in May 2001, causing much less loss than a comparable August 1985 storm event (WEMA 2001a, WEMA 2001b, Associated Press 2001).

Landslide Hazards

Landslides present in the Project Area occur in bedrock, debris, or earth, as topples, slides, spreads, flows, or a combination of these types (Case 1997, Case 2001). Landslide densities are high along the Little Powder River north of Gillette, along the Powder River in Johnson and Sheridan Counties, and in western portions of Johnson and Sheridan Counties (WWRDS 2001b). Minimization of mass movement is dependent, in part, on limiting additional disturbance to existing landslides and areas susceptible to movement.

Windblown Deposits

There are scattered occurrences of windblown sand deposits along the southeastern and eastern margins of the PRB. This type of deposit is subject to continuing migration unless stabilized by a good vegetative cover (Boyd et al. 1999).

Aquifer Collapse and Ground Subsidence

Case et al. (2000) describe the conditions present in areas where the removal of fluids from subsurface aquifers has caused subsidence and make a comparison with PRB conditions. The geologic conditions in the PRB are not the same as those observed in the cases cited below.

Where unconsolidated alluvial aquifers have collapsed in other geographic areas, due to dewatering, significant ground subsidence has occurred. In the United States, ground surface subsidence related to fluid withdrawal has been documented at a number of localities, including the San Joaquin Valley in California; Las Vegas, Nevada; New Orleans, Louisiana; and Houston, Texas. The common geological tie between these localities is that all are underlain by saturated, unconsolidated sands and gravels with interbeds and/or overlying beds of saturated clays. Water or oil is being removed (pumped) from the sands and gravels, causing ground subsidence.

In the PRB, the Fort Union Formation is a consolidated rock unit, and is not being substantially dewatered. The Fort Union Formation is only being partially dewatered to the top of the coal seam. The bedrock underlying the surface is compacted and consolidated. Instead of loose sand, sandstone is present; instead of unconsolidated clay, shale is present. However, even saturated bedrock, such as sandstone, can compress if water is removed under certain conditions.

Using a formula to estimate how much a confined aquifer may compress when water is removed, it appears that for CBM development levels analyzed in the Wyodak CBM Project EIS, minor aquifer compression up to 1/2 inch may occur in the coal beds that are being developed for coal bed methane in the Gillette area. That entire compression, however, may not be transmitted to the surface. To date, no surface subsidence has been associated with significant municipal water withdrawals in the Gillette area (Case et al. 2000, Edgar and Case 2000).

Gas Migration, Seepage, and Methane Venting

De Bruin et al. (2001) describe the conditions associated with methane migration, seepage, and venting. Methane seeps usually occur where coal beds are extremely close to the surface. Natural cracks or passageways for the gas to flow usually do not exist where the coal is deeper. Extraction of CBM removes the gas before it flows into shallower areas.

The methane contained in Fort Union coals is present in a free state, adsorbed on interior pore surfaces and micropores of the coal matrix, and dissolved in water contained within the coal seam. Reducing the hydrostatic pressure on the coal seam by pumping off the water enhances the release and production of methane previously trapped in the coal matrix as well as gas dissolved in the water.

Methane seepage can occur naturally in the vicinity of near-surface coal seams (Glass et al. 1987, Jones et al. 1987). The potential for methane migration within the PRB is not limited to areas containing near-surface coal seams or areas where dewatering has occurred. Methane migration potentially could occur at widespread locations within the PRB, as methane can migrate long distances along naturally-occurring joints or fractures in rocks, as well as up poorly-completed wells and drill holes. If near surface coals were to burn, the introduction of methane to the outcrop area, through seepage, could intensify the natural process of combustion if the methane were to burn along with the coal.

Spontaneous Combustion of Coals

In the PRB and other regions where coal occurs at or near the surface, exposures of clinker can be associated with coal outcrops, marking the locations where coal has burned in place. Burning coal in the PRB is a natural process which has been going on ever since erosion began to expose the coal beds (Coates 1991). It has long been recognized that spontaneous combustion, range fires, and lightning, cause coal outcrops to burn naturally, producing clinker (Rogers 1918).

Lyman and Volkmer (2001) summarize the history and occurrence of coal fires in the PRB. Coal outcrop fires occurred during the Tertiary period several million years ago and have continued to the present.

Clinker outcrops are concentrated in the following areas: along the eastern boundary of the Project Area in the Rochelle Hills; within the Powder River Breaks in the northern portion of the Project Area; within the Tongue River Breaks north of Sheridan; within the Lake De Smet area north of Buffalo; and within the Felix area west of Gillette and northeast of Wright (Heffern and Coates 1997). As coal burns, the burn front advances into the hillside until, with increasing depth, fissures in deposits overlying the coal fail to reach the surface. At that point, the supply of air to the coal is cut off, extinguishing the fire (Coates and Heffern 1999, Heffern and Coates 1999).

Environmental factors contributing to the self-ignition of coals are the exposure of coals to oxygen, causing oxidation to occur and releasing heat, and the exposure of dry coals to moisture, producing heat during the wetting process. Small particles of coal have a greater surface area available for oxidation to take place and are highly susceptible to self-ignition (Lyman and Volkmer 2001).

The coals in the PRB contain reactive materials required for spontaneous combustion. However, conditions favoring the self-ignition of coal are not present in the immediate vicinity of CBM wells. Lyman and Volkmer (2001) compare the conditions favoring spontaneous combustion of coal to conditions associated with mining and CBM development. Unlike surface coal mining, during CBM development the likelihood of completely dewatering a coal bed and exposing large areas of fine coal particles to oxygen is extremely remote. Unlike abandoned underground mines, CBM wells leave no underground voids susceptible to further subsidence and associated spontaneous coal ignition.

Lyman and Volkmer (2001) also compare conditions favoring spontaneous combustion of coal to CBM development activities in the PRB. During the production phase of CBM activity, conditions necessary to foster spontaneous combustion of coal are not present. CBM wells are designed to keep oxygen (a contaminant) out, and to maintain airflow in a direction out of the well. Any heat generated is vented to the surface before there is enough build up to result in coal ignition. The relatively small diameter of a CBM wellbore prohibits large volumes of fines from accumulating. Fines that do accumulate are flushed from the hole prior to production or during well maintenance. Faults and fractures that may be present in the overburden are sealed via casing and cement. After methane production ceases, CBM wells are plugged and sealed.

Soils

Soils within the Project Area have developed in residual material and alluvium in a climatic regime characterized by cold winters, warm summers, and low to moderate precipitation. The upland soils are derived from both residual material (derived from flat-lying, interbedded sandstone, siltstone, and shale) and stream alluvium. Valley soils have developed in unconsolidated stream sediments including silt, sand, and gravel. Soils are generally low in organic matter and are alkaline (Lowry et al., 1986). Textures range from clay loams to sandy loams with varying amounts of gravel or coarser materials. Slopes range from nearly level to very steep with deeper soils found in the less steeply sloping areas. These soils support little crop agriculture except in irrigated valleys of perennial streams. The predominant land use is rangeland. Vegetation is predominantly grass-shrub that is used for grazing and wildlife habitat.

County soil surveys have been completed in Sheridan, southern Johnson, southern Campbell, and northern Converse counties. However, county surveys are still in the preliminary mapping stages in northern Johnson and northern Campbell counties. Because of the incomplete county-level soil survey coverage and the large geographical area involved, STATSGO mapping for the state of Wyoming was used to provide generalized soils coverage for the Project Area. Although the STATSGO mapping is adequate for this level of analysis, it is insufficient for use in locating specific well pads, access roads, pipelines, and other associated facilities.

Each association in STATSGO is named for the three dominant soil series within that association. The areal extent of all STATSGO map units in the Project Area are listed in Table 3–11. Characteristics for each of these dominant soil series were identified using both the published and preliminary county soil surveys. In addition, slope data were used in combination with series data to identify areas with higher potential for water erosion.

Table 3–11 General Soils Information – Areal Extent of Soil Units

STATSGO Map Unit	Map Unit Name	Percent of Area
WY002	Midway - Samday - Rock Outcrop	0.20
WY004	Haverson - Glenberg - Bone	0.46
WY042	Cabbart - Yawdim - Hesper	0.20
WY043	Ridge - Broadus - Reeder	0.05
WY044	Havre - Hanly - Glendive	0.16
WY045	Cabbart - Yawdim - Thurlow	0.49
WY046	Cabba - Ringling - Yawdim	0.55
WY047	Draknab - Arvada - Bidman	0.41
WY048	Riverwash - Haverdad Clarkelen	2.50
WY049	Shingle - Renohill - Forkwood	8.12
WY050	Shingle - Taluce - Kishona	11.47
WY051	Wyarno - Hargreave - Moskee	0.72
WY053	Shingle – Cushman - Taluce	3.22
WY055	Haverdad - Havre - Zigweid	2.08
WY056	Samday - Shingle - Rock Outcrop	0.56
WY057	Doney - Shaak - Wayden	0.92
WY058	Abac - Peritsa - Rock Outcrop	<0.01
WY059	Rock Outcrop - Starley - Woosley	2.69
WY060	Tolman - Abac - Rock Outcrop	0.67
WY061	Agneston - Rock Outcrop - Granile	0.55
WY062	Owen Creek - Tongue River - Gateway	<0.01
WY063	Wolf - Platner - Platsher	1.48
WY064	Plashter - Recluse - Parmleed	0.99
WY065	Baux - Bauxson - Harlan	2.50
WY066	Moskee - Hargreave - Shingle	1.20
WY078	Frisco - Troutville - Teewinot	0.04
WY081	Barnum - Haverdad - Rock Outcrop	0.40
WY082	Reno - Shingle - Parmleed	8.17
WY084	Keyner - Samday - Rock Outcrop	1.93
WY085	Samday - Badland - Rock Outcrop	0.81
WY086	Cambria - Shingle - Kishona	1.44
WY087	Shingle - Cambria - Renohill	0.83
WY088	Sunup - Rock Outcrop - Spearfish	1.55
WY114	Tassel - Turnercrest - Terro	0.01
WY115	Shingle - Samday - Absted	0.21
WY124	Plashter - Kishona - Hiland	1.98
WY125	Shingle - Theedle - Wibaux	2.40
WY126	Hiland - Vonalee - Maysdorf	4.27
WY127	Kishona - Shingle - Theedle	4.10
WY128	Renohill - Cushman - Cambria	3.15
WY129	Bidman – Parmleed - Renohill	2.70
WY130	Renohill - Bidman - Ulm	6.29
WY203	Clarkelen - Draknab - Haverdad	0.25
WY204	Hiland - Ustic Torriorthents - Bowbac	1.50
WY205	Dwyer - Orpha - Hiland	0.61
WY206	Wibaux - Rock Outcrop - Shingle	1.40
WY207	Hiland - Bowbac - Tassel	3.02

Table 3–11 General Soils Information – Areal Extent of Soil Units

STATSGO Map Unit	Map Unit Name	Percent of Area
WY208	Shingle - Samday - Hiland	1.53
WY209	Hiland - Shingle - Tassel	5.52
WY210	Ulm - Renohill - Shingle	1.33
WY211	Shingle - Tassel - Rock Outcrop	1.74
WY315	Rock Outcrop - Hazton - Redsun	0.20
WY316	Hiland - Bowbac - Keyner	<0.01
WY317	Shingle - Taluce - Amodac	0.10
WY321	Hiland - Orpha - Bowbac	0.08
WY322	Roughlock - Rock Outcrop - Rekop	0.08
WY323	Lolite - Hiland - Vonalee	0.01
WY324	Hiland - Forkwood - Zigweid	0.11
WY325	Lolite - Rock Outcrop - Keyner	0.06
WYW	Surface Water	0.02

Soil Descriptions

Appendix F lists the dominant soil series for all the associations in the Project Area. For each series, the general characteristics of the soil are listed. Series with severe wind and water erosion hazards, high compaction potential (based on high shrink-swell capacity), high salinity, soils with a poor revegetation potential, and prime or otherwise valuable agricultural soils are marked in the table. A brief description of each parameter in the table follows this discussion.

“Rock Outcrop” is listed numerous times in Table 3–11 as one of the three predominant soil types in the series. Though the nature of this outcrop is not described in county soil surveys, the “Rock Outcrop” notation refers to exposed bedrock or a formation known as clinker. Clinker, also referred to as “scoria”, is rock that has been baked by subsurface coal fires and has migrated to the surface. This baked rock is highly resistant to erosion and as a result, clinker is often found atop plateaus and ridges in the Powder River Basin. The Geology section (beginning on page 3–31) describes clinker concentrations in the Project Area in more detail.

Generally, clinker consists of fractured rock on a base of porous ash. Semipermeable clay frequently underlies clinker formations (Heffern and Coates, 1999). This structure allows clinker to absorb, store, and transfer large amounts of water. The quality of water from clinker aquifers is highly variable but in general, TDS values are lower for older formations (Heffern and Coates, 1999). The irregular terrain of clinker formations provides a unique habitat for plant and animals species that would otherwise not survive on the treeless plain (Heffern and Coates, 1999). Clinker is not considered a valuable agricultural soil and has a very poor revegetation potential. Rock outcrop soil types that do not refer to clinker are most likely exposed sandstone, shale, or other bedrock. Like clinker, this exposed bedrock has poor revegetation potential, but provides valuable wildlife habitat.

Wind Erosion Hazard

Severe wind erosion hazards were identified by determining the wind erosion group for each soil. These groups are based on soil texture (grain size, parent material, cohesiveness, wetness, etc.), and indicate how susceptible a soil is to wind erosion. Nine groupings have been developed (1, 2, 3, 4, 4L, 5, 6, 7, 8), the lower the number, the greater the risk of wind erosion. Group 1 includes soils that consist entirely of fine sand, which is highly susceptible to wind erosion, and Group 8 contains very wet or stony soils, which are not at all subject to wind erosion. Soils listed in Groups 1 and 2 were considered Severe Hazards for this section.

Severe wind erosion hazards primarily run down the center of Campbell County from the Wyoming-Montana border to about 14 miles south of Gillette and along the Little Powder River. These soils cover much of Converse County as well (Figure 3–6).

Slope Hazards

A soil's stability is greatly affected by the slope on which it occurs. In general, the greater the slope, the greater the potential for slumping, landslides and water erosion. Slope ranges used to identify slope hazards were determined by the USDA National Soil Survey Handbook and appropriate COAs. For this analysis, slopes from 0 to 25 percent are considered minimal hazards, 25 to 40 percent slopes are moderate, and slopes 40 and above are considered severe hazards. Hazards for minimal slopes have been further broken down in the Water Erosion Hazard Section. These ranges are quite general and the exact stability and susceptibility to water erosion depends greatly on each soil's characteristics.

Severe and moderate slope hazards in the Project Area occur primarily along the southwest corner of the Project Area in Johnson County (Figure 3–6). Small areas of these slope hazards are scattered throughout the Project Area as well.

Water Erosion Hazard

Severe water erosion hazards were identified using permeability classes, K-factor, and slope. Slopes above from 25 to 40 percent are considered moderate water erosion hazards and slopes 40 percent and above are considered severe water erosion hazards.

As so much of the Project Area falls within the 25 percent and below slope range, permeability class and K-factor for each soil type were used to determine which soils might be more susceptible to water erosion on gentle topography. At slopes less than 5 percent, only the least permeable and highest K-factor soils (neither of which occur in the Powder River Basin) are susceptible to water erosion. At slopes greater than 25 percent, only the most permeable and lowest K-factor soils (neither of which occur in the Powder River Basin) are not susceptible to water erosion (U.S. Department of Agriculture, Soil Conservation Service 1994).

Figure 3–6 Soils and Slope

Water erosion hazards for soils on slopes between 5 percent and 25 percent were identified with permeability classes and K-factors. Soil permeability classes were determined by infiltration rates in inches per hour. Rates from 0 to 0.2 in/hr were considered slow, 0.2 through 6.0 inches/hour moderate and 6.0 in/hr and greater were considered rapid. Generally, primarily sandy soils had the greatest infiltration rates, while clayey soils had very slow infiltration rates.

K–factor is one of six factors used in the Universal Soil Loss Equation to predict annual rate of soil loss due to water erosion. Soil structure, percentage of silt, sand, and organic matter, and permeability all affect the K-factor of a soil (U.S. Department of Agriculture, Natural Resources Conservation Service [NRCS] 1986a,b,c). Values for K range from 0.02 to 0.69. The higher value, the more susceptible the soil is to water erosion. Soils with low permeability and high K–factors were determined to be severe water erosion hazards for slope ranges between 5 percent and 25 percent (SCS 1994).

Severe and moderate water erosion hazards (based on the 25 to 40 percent and 40 percent and above slope ranges) in the Project Area occur primarily along the southwest corner of the Project Area in Johnson County. Soils with severe water erosion potential in the five to 25 percent slope range occur along the northern and eastern borders of the Project Area and extend down the center of the Project Area along the Powder River and into Converse County.

Compaction/Shrink-Swell Potential

Compaction and shrink-swell potential affect a soil's ability to support construction and to be reclaimed. Both characteristics are related to the amount of clay in a soil. A soil with a high clay content is very compactable and has a high shrink-swell potential. Clay grains are extremely small and can be forced so closely together that few pore spaces remain. Thus, most air and water is pushed out of the soil. In addition, the soil grains may become so tightly compacted that plants roots would not be able to penetrate the soil. Due to the absence of air and water and the difficulty of root growth, reclamation of a tightly compacted clay soil is extremely difficult without loosening the soil prior to seeding.

Shrink-swell potential is the potential for volume change in a soil with a gain or loss in moisture. Like compaction, a soil's shrink-swell potential is determined partially by its clay content. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to capacity. A change of 3 percent is considered low, 3-6 percent is moderate and a change of greater than 6 percent is classified as high. In soils with a high shrink-swell potential, rapid changes in volume can damage structures and roads (NRCS 1986a,b,c). Soils classified as high shrink-swell potential in the county soil survey are marked as severe hazards in this section.

Severe shrink-swell potential soils occur along the northern and western borders of the Project Area and on either side of the Powder River, down the center of Sheridan and Johnson Counties and the eastern portion of Campbell County. The entire south half of Campbell County and small, widely separated portions of Converse County are dominated by these soils also.

Salinity

The SAR, or sodicity, of surface water and groundwater and salinity of soils are important chemical characteristics due to their effects on plant life and soils productivity. SAR is the ratio of the concentration of sodium ions relative to calcium and magnesium ions in water. Salinity is a measure of soluble salts in the soil, measured as conductivity in millimhos per centimeter at 25°C (mmhos/centimeters). SAR can only be measured in water, whereas salinity can be measured in both soil and water. Salinity detracts from a plant's ability to take in water, whereas sodicity slows the movement of water through the soil.

Plant roots exclude salt from the water they extract from the soil. In highly saline water, a plant must expend significant energy to take in water. This expenditure diverts energy from growth and reproduction, reducing the productivity of the plant. Soils with salinity levels from 0 to 8 mmhos/centimeters are considered slightly saline, soils with levels of 8 to 16 mmhos/centimeters are considered moderately saline and soils with salinity levels above 16 mmhos/centimeters are considered strongly saline.

Sodium is attracted to clay particles and will fill pore spaces in the soil, restricting the movement of water through the soil. As clays have much smaller pore spaces and greater attraction to sodium than any other soil constituent, a water with a high SAR value affects clayey soils faster than coarser soil types. SAR values between 10 and 15 are considered high. SAR levels in surface water are discussed in more detail in the sections on Surface Water quality (beginning on page 3–23).

Salinity in soils can be affected by the SAR in surface water and the duration of exposure to that water. Consequently, the salinity of soils can change rapidly over time and can differ greatly between similar soils types depending on the quality of the local water and the irrigation program. Additionally, any soil that is poorly drained, like clay, has flat slopes, impermeable bedrocks, or is flooded frequently, could retain water and concentrate salts.

Small sections of the Project Area concentrated near the confluence of the Powder River and the South Fork of the Powder River and along the Bell Fourche River, Black Thunder and Little Black Thunder creeks are classified as high salinity. The saline soils in these areas most likely occupy toe slopes, alluvial fans, and stream terraces. Soils near or downstream from coal mines have also been found to be highly saline (Tidball and Ebens, 1976). These statements are very general possible locatios for saline soils. Chemical characteristics in soils can vary greatly over a large geographic area, regardless of soil type.

Poor Revegetation Potential

Soils with poor revegetation potential were determined using the land capability classification given in the county soil surveys. Soils are grouped according to their limitations for field crops, the risk of damage if used for agriculture, and response to management. Capability classes are divided into eight groups (Roman Numerals I–VIII), with Class I soils having few limitations and Class VII soils having multiple limitations that prevent commercial crop production. Class VII and Class VIII soils were determined have poor revegetation potential for this analysis.

Soils with poor revegetation potential occur throughout the Project Area, except the central portion of Campbell County.

Prime Agricultural Soils

Prime soils were identified by the Wyoming state office of the NRCS. Sheridan County, Converse County and the central section of Campbell County are covered extensively by prime agricultural soils. Additionally, these soils extend into Johnson County along the Powder River and Clear Creek.

Air Quality and Climate

The air quality of any region is controlled primarily by the magnitude and distribution of pollutant emissions and the regional climate. The transport of pollutants from specific source areas is strongly affected by local topography. In the mountainous western United States, topography is particularly important in channeling pollutants along valleys, creating upslope and downslope circulations that may entrain airborne pollutants, and blocking the flow of pollutants toward certain areas. In general, local effects are superimposed on the general synoptic weather regime and are most important when the large-scale wind flow is weak.

Topography

The Project Area is located in the southern portion of the PRB of the northwestern Great Plains Steppe in northeastern Wyoming. The Great Plains Steppe is a large physiographic province extending throughout most of eastern Wyoming, Montana and Colorado, as well as portions of western North and South Dakota, Nebraska, Kansas, and the Oklahoma panhandle. The topography of the Project Area varies from moderately steep to steep mountains and canyons in the western portions, to rolling plains and tablelands of moderate relief (with occasional valleys, canyons and buttes) in the eastern regions. Elevations generally range from about 3,000 to 5,000 feet above mean sea level, with mountain peaks rising to over 10,000 feet west of the Project Area.

Climate and Meteorology

Because of the variation in elevation and topography throughout the Project Area, climatic conditions vary considerably. Most of the area is classified as a semi-arid cool steppe, where evaporation exceeds precipitation, with relatively short warm summers and longer cold winters. On the plains, average daily temperatures typically range from 5 to 10 (low) and 30 to 35 (high) degrees Fahrenheit (°F) in mid-winter, and between 55 to 60 (low) and 80 to 85 (high) degrees

Fahrenheit in mid-summer. The frost-free period (at 32°F) generally occurs for 120 days between late May and mid-September. The annual average total precipitation is nearly 12 to 16 inches, with 36 to 60 inches of total annual snowfall. Temperatures generally are cooler, frost-free periods shorter, and both precipitation and snowfall greater at the higher elevations, including the mountains along the western margin of the Project Area.

Prevailing winds occur from the southwest, but local wind conditions reflect channeling (mountain and valley flows) due to complex terrain. Nighttime cooling enhances stable air, inhibiting air pollutant mixing and transport along the valley drainages. Dispersion potential improves along ridge and mountain tops, especially during winter-spring weather transition periods and summer convective heating periods. Given the lack of representative wind measurements throughout the Project Area, regional wind speed and direction values for air quality modeling were derived from the MM4 (mesoscale model) and CALMET meteorological models (Argonne 2001).

Existing Air Quality

Although specific air quality monitoring is not conducted throughout most of the Project Area, air quality conditions in rural areas are likely to be very good, as characterized by limited air pollution emission sources (few industrial facilities and residential emissions in the relatively small communities and isolated ranches) and good atmospheric dispersion conditions, resulting in relatively low air pollutant concentrations. Occasional high concentrations of carbon monoxide (CO) and particulate matter may occur in more urbanized areas (e.g. Buffalo, Gillette, and Sheridan) and around industrial facilities, especially under stable atmospheric conditions common during winter.

Anticipated contributors to pollutant levels within the region include the following:

- exhaust emissions (primarily carbon monoxide and oxides of nitrogen [NO_x]) from existing natural gas fired compressor engines used in production of natural gas; gasoline and diesel vehicle tailpipe emissions of combustion pollutants (Volatile Organic Compounds [VOC], CO, NO_x, inhalable particulate matter less than 10 microns in effective diameter [PM_{10}], fine particulate matter less than 2.5 microns in effective diameter [$PM_{2.5}$], and sulfur dioxide [SO_2]);
- dust (particulate matter) generated by vehicle travel on unpaved roads and windblown dust from neighboring areas and road sanding during the winter months;
- transport of air pollutants from emission sources located outside the region;
- dust from coal mines; and
- SO_2 and NO_x from power plants.

As part of the analysis, monitoring data obtained throughout the northeastern Wyoming and southeastern Montana were assembled and reviewed. Although monitoring is primarily conducted in urban or industrial areas, the data are considered the best available representation of background concentrations of air pollutants throughout the Project Area. These values are presented in Table 3–13, along with applicable ambient air quality standards and Prevention of Significant Deterioration (PSD) increments, and were used to define background conditions for the analysis of effects to air quality. The assumed background pollutant concentrations are below applicable National Ambient Air Quality Standards (NAAQS) and Wyoming Ambient Air Quality Standards for most pollutants and averaging times, although monitored hourly background concentrations of NO_x, ozone and SO_2 are not available.

Air Quality Related Values — Visibility and Acidification of Lakes

Air Quality Related Values (AQRVs), including the potential effects of air pollutant on visibility and the acidification of lakes and streams, are applied to PSD Class I areas. The land management agency responsible for the Class I area sets each AQRV as the level of acceptable change (LAC). The AQRVs reflect the land management agency's policy and are not treated as legally enforceable standards.

Visibility

Potential impacts to visibility were considered at 16 PSD Class I and Class II areas near the PRB region. Table 3–12 shows the nearest distances from the sensitive receptor areas to the proposed project area.

Table 3–12 Distances from the Project Area to PSD Class I and Class II Sensitive Receptor Areas

Receptor Area	PSD Class	Distance (miles)
Badlands National Park		112
Bridger Wilderness Area	I	152
Fitzpatrick Wilderness Areas		147
N. Absaroka Wilderness Area		118
N. Cheyenne Reservation		25
Washakie Wilderness Area		117
Wind Cave National Park		81
Agate Fossil Beds National Monument		102
Big Horn Canyon National Recreation Area	II	51
Black Elk Wilderness Area		81
Cloud Peak Wilderness Area		13
Devil's Tower National Monument		36
Fort Laramie National Historic Site		90
Jewel Cave National Monument		67
Mt. Rushmore National Monument		85
Soldier Creek Wilderness Area		99

Table 3–13 Assumed Background Air Pollutant Concentrations, Applicable Ambient Air Quality Standards, and PSD Increment Values (in µg/m3)

Pollutant	Averaging Time[1]	Background Concentration	Primary NAAQS[2]	Secondary NAAQS[2]	Wyoming Standards	PSD Class I Increments	PSD Class II Increments
Carbon monoxide[3]	1-hour	3,500	40,000	40,000	40,000	-----	-----
	8-hour	1,500	10,000	10,000	10,000	-----	-----
Nitrogen dioxide[4]	Annual	16.5	100	100	100	2.5	25
Ozone[5]	1-hour	n/a[6]	235	235	157	-----	-----
	8-hour	130	157	157	-----	-----	-----
PM_{10}[4]	24-hour	42	150	150	150	8	30
	Annual	17	50	50	50	4	17
$PM_{2.5}$[4]	24-hour	19	65	65	65	-----	-----
	Annual	7.6	15	15	15	-----	-----
Sulfur dioxide[7]	3-hour	8	-----	1,300	1,300	25	512
	24-hour	8	365	-----	260	5	91
	Annual	3	80	-----	60	2	20

Notes:
1. Annual standards are not to be exceeded; short-term standards are not to be exceeded more than once per year.
2. Primary standards are designed to protect public health; secondary standards are designed to protect public welfare.
3. per Riley Ridge EIS (BLM 1993)
4. Data collected in Gillette, WY (1996 - 1997, and 1999)
5. Data collected in Pinedale, WY (1992 - 1994)
6. n/a = not available
7. Data collected at Devil's Tower, WY (1983)

Source: (Argonne 2001)

Visibility can be defined as the distance one can see and the ability to perceive color, contrast, and detail. Fine particulate matter ($PM_{2.5}$) is the main cause of visibility impairment. Visual range, one of several ways to express visibility, is the furthest distance a person can see a landscape feature. Maximum visual range in the western United States would be about 140 miles. Presently, the best-monitored visibility in the United States is in the Bridger Wilderness Area. Visual range monitoring in the Bridger Wilderness Area shows that one can see more than 70 miles 70 percent of the time.

Visibility impairment is expressed in terms of deciview (dV). The deciview index was developed as a linear perceived visual change. A change in visibility of 1.0 dV represents a "just noticeable change" by the average person under most circumstances. Increasing dV values represent proportionately larger perceived visibility impairment. Figure 3–7 and Figure 3–8 below show average annual visibility at Badlands National Park and Bridger Wilderness from 1988 to 1998, respectively.

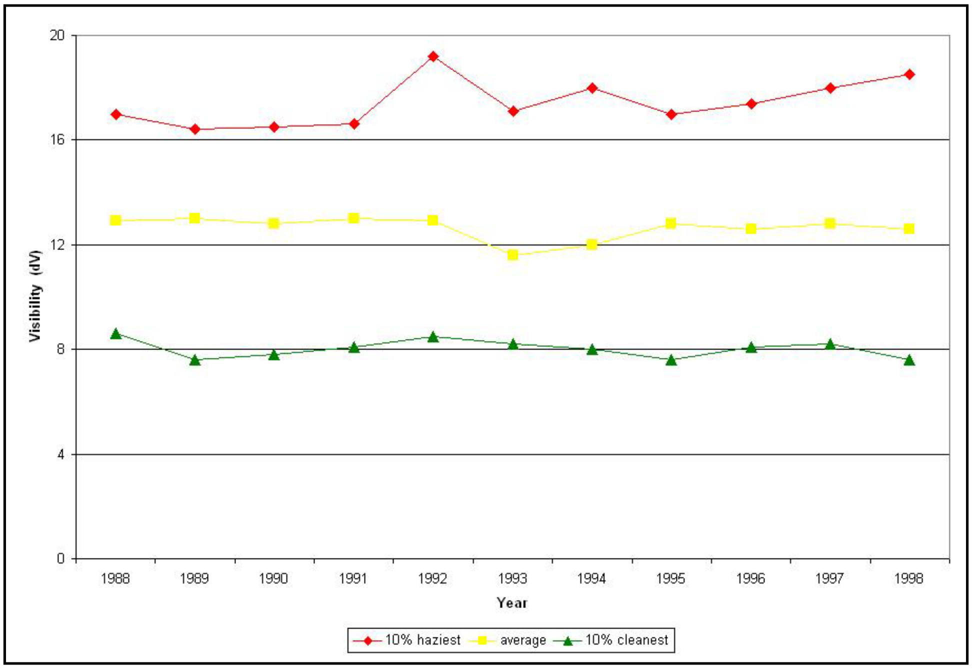

Figure 3–7 Visibility in the Badlands National Park

Acidification of Lakes

The acidification of lakes and streams is caused by atmospheric deposition of pollutants (acid rain). Lake acidification is expressed as the change in acid neutralizing capacity (ANC), the lake's capacity to resist acidification from acid rain. Table 3–14 shows the existing ANC monitored in mountain lakes within the study area.

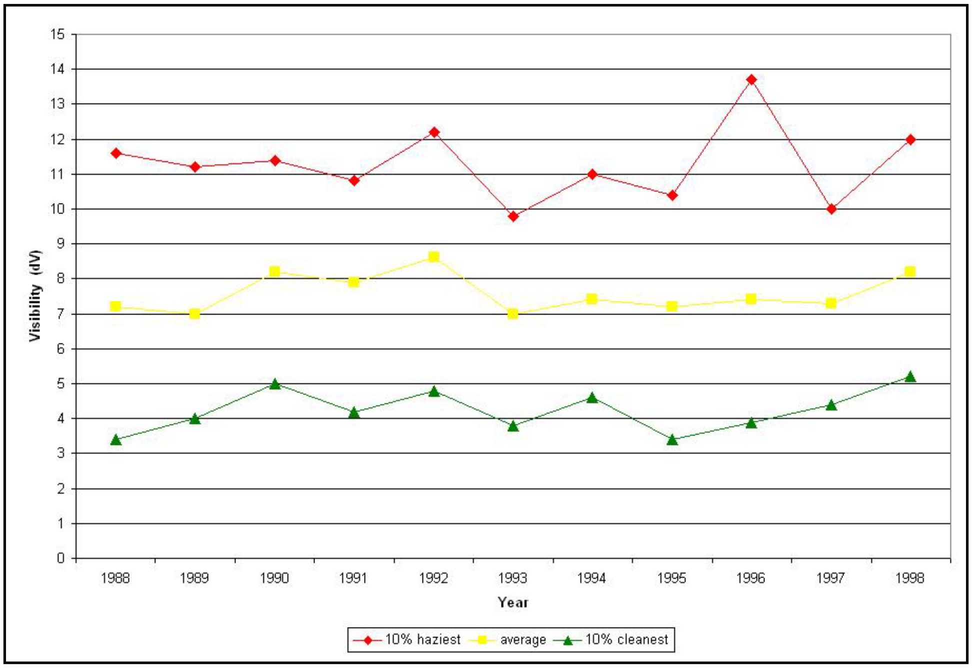

Figure 3–8 Visibility in Bridger Wilderness

Table 3–14 Existing Acid Neutralizing Capacity in Sensitive Lakes

Wilderness Area	Lake	Background ANC (µeq/L)
Bridger	Black Joe	69.0
	Deep	61.0
	Hobbs	68.0
Cloud Peak	Emerald	55.3
	Florence	32.7
Fitzpatrick	Ross	61.4
Popo Agie	Lower Saddlebag	55.5

Regulatory Framework

The National and Wyoming Ambient Air Quality Standards set the absolute upper limits for specific air pollutant concentrations at all locations where the public has access. Existing air quality throughout most of the Project Area is in attainment with all ambient air quality standards, as demonstrated by the relatively low concentration levels presented in Table 3–13. However, the Sheridan, Wyoming area has been designated as Federal non-attainment area (PM_{10} – moderate) where the applicable standards have been violated in the past.

Mandatory Federal Class I areas were designated by the U.S. Congress on August 7, 1977, and include wilderness areas greater than 5,000 acres in size and national parks greater than 6,000 acres in size. In addition, the Northern Cheyenne Tribe (located north of the Project Area in Montana) has re-designated their lands as PSD Class I. The allowable incremental impacts for NO_2, PM_{10}, and SO_2 within these PSD Class I areas are very limited. Most of the Project Area is designated as PSD Class II with less stringent requirements.

Vegetation and Land Cover Types

WGFD land cover classifications mapping and Gap Analysis Project (GAP) resources were used to identify vegetation types within the Project Area. Fourteen vegetation types were identified within the Project Area: short-grass prairie, mixed-grass prairie, wet meadow, herbaceous riparian, sagebrush shrubland, other shrubland, shrubby riparian, coniferous forest, aspen, forested riparian, agriculture, urban/disturbed, barren, and water. These broad categories often represent several vegetation types that were similar in terms of dominant species and ecological importance.

The Project Area is characterized as a mosaic of vegetation types that includes prairie grasslands, shrublands, riparian areas, and forested areas (Figure 3–9). The occurrence and relative distribution of the vegetation types are presented by surface owner and sub-watershed in Table 3–15 and Table 3–16, respectively. These major vegetation types are described in the following text.

Table 3–15 Distribution of Vegetation Types by Surface Owner

	BLM					
Vegetation Type	BFO	CFO	FS	State	Private	Total
Agriculture	231	18	0	4,729	108,666	113,644
Aspen	0	0	0	2	69	71
Barren	18,104	2,886	2,631	19,034	72,870	115,525
Coniferous Forest	46,442	5,804	5,553	29,050	105,337	192,186
Forest Riparian	251	0	285	2,930	8,026	11,492
Herbaceous Riparian	26	413	617	3,298	7,984	12,338
Mixed-grass Prairie	91,202	25,251	28,519	261,006	1,142,551	1,548,529
Other Shrublands	51,952	1,605	262	26,923	97,141	177,883
Sagebrush Shrublands	187,969	27,287	85,627	279,488	1,653,758	2,234,129
Shortgrass Prairie	399,087	27,741	149,871	434,409	2,262,781	3,273,889
Shrubby Riparian	734	32	90	5,879	52,183	58,918
Urban/Disturbed	0	0	0	34	4,328	4,362
Water	242	29	121	519	8,279	9,190
Wet Meadow	1,521	0	553	27,365	129,500	158,939
Total	797,761	91,066	274,129	1,094,666	5,653,473	7,911,095

Table 3–16 Distribution of Vegetation Types by Sub-watershed

	Vegetation Type														
Sub-watershed	Agriculture	Aspen	Barren	Coniferous Forest	Forest Riparian	Herbaceous Riparian	Mixed Grass Prairie	Other Shrublands	Sagebrush Shrublands	Shortgrass Prairie	Shrubby Riparian	Urban/Disturbed	Water	Wet Meadow	Total
Little Bighorn River	683	0	0	4,497	601	0	22,088	190	4,331	1,094	10,607	0	44	5,450	49,585
Upper Tongue River	59,055	12	4,122	15,269	3,172	67	303,684	538	119,744	124,205	32,931	0	1,106	75,987	739,892
Middle Fork Powder River	584	3	16,300	50,711	1,767	5	107,781	106,069	61,805	117,615	173	0	202	1,441	464,456
North Fork Powder River	0	0	0	3,060	1,628	0	8,583	643	4,788	109	0	0	0	1,864	20,675
Upper Powder River	5,958	0	25,153	6,715	0	0	108,275	13	424,952	1,020,649	582	0	1,385	9,857	1,603,539
South Fork Powder River	1	0	1,803	2,545	48	0	24,745	30,090	12,255	42,725	0	0	145	0	114,357
Salt Creek	0	0	186	3,563	0	0	3,892	779	42,589	101,204	0	0	148	0	152,361
Crazy Woman Creek	8,567	56	9,114	33,127	636	46	112,692	15,892	124,134	237,519	1,059	0	426	5,021	548,289
Clear Creek	27,184	0	4,754	11,510	1,033	41	170,382	1,799	128,220	156,874	9,347	0	3,607	32,732	547,483
Middle Powder River	1,143	0	3,265	10,637	0	0	72,552	0	47,363	81,889	547	0	0	6,836	224,232
Little Powder River	998	0	9,447	26,103	0	0	172,186	0	375,460	267,553	1,750	0	636	11,359	865,492
Little Missouri River	320	0	144	567	0	0	20,842	0	7,174	5,853	550	0	0	3,078	38,528
Antelope Creek	398	0	5,096	6,750	948	0	15,337	387	124,619	506,341	0	0	430	0	660,306
Dry Fork Cheyenne River	795	0	8,828	9,040	1,518	5,198	105,619	1,340	58,899	116,899	771	384	29	0	309,320
Upper Cheyenne River	108	0	2,771	4,477	141	114	6,147	0	87,730	104,631	169	0	419	99	206,806
Lightning Creek	7,086	0	2,093	0	0	4,263	95,125	20,143	166,207	11,710	0	1,698	0	0	308,325
Upper Belle Fourche River	764	0	18,302	3,355	0	0	85,963	0	353,210	377,019	432	0	613	5,215	844,873
Middle North Platte Casper	0	0	4,147	260	0	2,604	112,636	0	90,649	0	0	2,280	0	0	212,576
Total	113,644	71	115,525	192,186	11,492	12,338	1,548,529	177,883	2,234,129	3,273,889	58,918	4,362	9,190	158,939	7,911,095

Source: BLM 2001e

Figure 3–9 Distribution of Vegetation Types within the Project Area

Short-grass Prairie

The short-grass prairie vegetation type accounts for 3,273,889 pre-disturbance acres (41 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and by surface owner within the Project Area. This vegetation type represents very sparse, sparse, and thin dry herbaceous rangeland types, as defined by the WGFD.

Short-grass prairie occurs on drought-prone, mildly alkaline, medium and fine-textured soils. Few shrubs grow consistently in short-grass prairie because the soils are too dry and compacted to support them. Precipitation is an important determinant of the plant species composition in grasslands. Average annual precipitation for short-grass prairie is between 10 and 16 inches (CNAP 1998). In Wyoming, short-grass prairie occurs primarily in the southeastern portion of the state and southward into Colorado. Within the Project Area, short-grass prairie habitats are most common in the south, occurring as the dominant plant community from the southern foothills of the Bighorn Mountains to the eastern Project Area boundary. Plant species common to the short-grass prairie include blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), western wheatgrass (*Pascopyrum smithii*), sand dropseed (*Sporobolus cryptandrus*), needle-and-thread (*Stipa comata*), scarlet globemallow (*Sphaeralcea coccinea*), and fourwing saltbush (*Atriplex canescens*).

Mixed-grass Prairie

The mixed-grass prairie vegetation type accounts for 1,548,529 pre-disturbance acres (19 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This vegetation type is a combination of low, medium, and high herbaceous rangeland types, as defined by WGFD.

Mixed-grass prairie can be divided into several types and is characterized by several common species including needle-and-thread, western wheatgrass, blue grama, pricklypear cactus (*Opuntia compressa*), and scarlet globemallow. Wyoming big sagebrush (*Artemisia tridentat* var. *Wyomingensis*) is a common shrub of this grass community in the Powder River Basin (Knight 1994). Within the Project Area, mixed-grass prairie habitats are most common along the eastern foothills of the Bighorn Mountains and sporadically occur throughout much of the northern and central portions of the Project Area.

Wet Meadow

The wet meadow vegetation type accounts for 158,939 pre-disturbance acres (2 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This vegetation type is a combination of green and very green herbaceous rangeland types, as defined by WGFD.

Wet meadow is a grassland community that typically occurs where the water table is high enough to saturate the soil during a portion of the growing season. This community commonly occurs along reservoirs, springs, and irrigated pastures. Depending upon salinity and water table, common species include woolly sedge (*Carex laneuginosa*), common spike-rush (*Eleocharis palustris*), arctic rush (*Juncus arcteicus*), foxtail barley (*Hordeum jubatum*), and Canada goldenrod (*Solidago canadensis*) (CNAP 1998). Within the Project Area, wet meadow habitats are widely distributed and often insular in their occurrence. Although these habitats occur throughout the Project Area, wet meadows are more common in the north and west than in the south and east portions of the Project Area. Wet meadows tend to exist as island habitats surrounded by dominant plant communities such as grasslands or shrublands.

Herbaceous Riparian

The herbaceous riparian vegetation type accounts for 12,338 pre-disturbance acres (<1 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This vegetation type consists of a variety of riparian moist grasses, sedges, and rushes, as defined by WGFD.

The herbaceous riparian vegetation type includes species common to the wet meadow community, however, this vegetation type occurs near drainages including rivers, streams, and creeks. Common plant species may include woolly sedge, common spike-rush, foxtail barley, wild licorice (*Glycyrrhiza lepidota*), and Canada goldenrod. Very similar to the wet meadow community, this vegetation cover type often occurs in similar environments and supports similar plant species. Herbaceous riparian communities occur throughout the Project Area with most occurrences associated with streams, rivers, and other aquatic habitats.

Sagebrush Shrubland

The sagebrush shrubland vegetation type accounts for 2,234,129 pre-disturbance acres (28 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This vegetation type is the combination of sparse, moderately dense, and dense big sagebrush crown closure. A variety of understory grasses and forbs can occur as understory in this vegetation type.

The big sagebrush is widely distributed and occupies a large proportion of the Project Area. Plant species that typically occur in this community may include Wyoming big sagebrush, silver sagebrush (*Artemisia cana*), western wheatgrass, junegrass (*Koeleria macrantha*), needle-and-thread grass, Sandberg bluegrass (*Sandberg bluegrass*), pricklypear cactus, scarlet globemallow, and rabbitbrush (*Chrysothamnus* spp.) (Knight 1994). Sagebrush shrublands occur throughout the entire Project Area, with the Bighorn Mountains and associated foothills as the only exceptions. Although common in the southern portions of the Project Area, larger more contiguous tracts of sagebrush occur in the northeastern, central, and eastern portions of the Project Area.

Other Shrubland

The other shrubland vegetation type accounts for 177,883 pre-disturbance acres (2 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This vegetation category is comprised of shrub/grass mix, greasewood

(*Sarcobatus vermiculatus*), rabbitbrush, mountain mahogany (*Cercocarpus* spp.), and bur oak (*Quercus macrocarpa*), as defined by WGFD. This vegetation cover type is relatively uncommon and occurs primarily in the southwest corner of the Project Area.

Riparian Shrubby

The riparian shrubland vegetation type accounts for 58,918 pre-disturbance acres (<1 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This vegetation category includes a variety of shrubs and herbaceous plants existing adjacent to draws, gullies, and streams. Within the Project Area, plant species occurring in this community may include hawthorn (*Crataegus* spp.), chokecherry (*Prunus virginiana*), peachleaf willow (*Salix amygdaloides*), sandbar willow (*Salix exigua*), and other willow species (*Salix* spp.). This vegetation type occurs in small scattered locations throughout the Project Area.

Coniferous Forest

The coniferous forest vegetation type accounts for 192,186 pre-disturbance acres (2 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This vegetation type includes Englemann spruce (*Picea engelmannii*), Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta* var. *latifolia*), ponderosa pine (*Pinus ponderosa*), limber pine (*Pinus flexilis*), and juniper (*Juniperus* spp.), as defined by WGFD. These species tend to form associations based upon elevation, exposure, and soil moisture. Typically, these species are segregated according to elevation. Juniper and pine forests tend to be lower in elevation while spruce and fir forests occur at higher elevations. This vegetation type occurs primarily along the western edge of the Project Area, where the upper elevation conifer species are more common and in the northeastern corner where the lower elevation species are more common.

Aspen

The aspen vegetation type accounts for 71 pre-disturbance acres (<1 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. Aspen communities typically occur in depressions, ravines, valley bottoms, or on the lee sides of wedges. Aspen are intolerant of drier conditions, and therefore their distribution is typically dictated by soil moisture availability. Small areas of conifers may also occur in this vegetation type. This vegetation type is limited to the Bighorn Mountains in the Project Area.

Forested Riparian

The forested riparian vegetation type accounts for 11,492 pre-disturbance acres (<1 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This vegetation type is characterized by a variety of deciduous and coniferous tree species that occur along riparian areas, as defined by WGFD. Some of these species include plains cottonwood (*Populus deltoides*), narrow-leaf cottonwood (*Populus angustifolia*), quaking aspen (*Populus tremuloides*), boxelder (*Acer negundo*), ash (*Fraxinus pennsylvanica*), Russian olive (*Elaeagnus angustifolia*), and willow (*Salix* spp). This vegetation type occurs along the major drainages throughout the Project Area.

Agriculture

The agricultural vegetation type accounts for 113,644 pre-disturbance acres (<1 percent) with the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This land cover type is defined as croplands that are plowed and/or planted. These areas may also include wooded or shrubby draws and riparian areas. Agricultural areas are most common along the eastern edge of the Bighorn mountains, along the major drainages, and in the vicinity of Wright and Gillette.

Urban/Disturbed

The urban/disturbed vegetation type accounts for 4,362 pre-disturbance acres (<1 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This cover type includes lands covered by homes, businesses, streets, and unvegetated surface mining areas. It is most common around cities and towns and along the eastern edge of the Project Area where many coal mines are located.

Barren

The barren vegetation type accounts for 115,525 pre-disturbance acres (<1 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This cover type includes rock outcrops, roads, sandbars, eroded gullies, and areas with less than ten percent ground cover and perennial snow and ice areas, as defined by WGFD. It occurs as small, scattered areas throughout the Project Area, and as several large blocks in the southwest portion.

Water

The water cover type accounts for 9,190 pre-disturbance acres (<1 percent) within the Project Area. Table 3–15 and Table 3–16 present the relative distribution among the sub-watersheds and surface owners within the Project Area. This land cover type includes lakes, ponds, streams, and open water in wetlands, as defined by WGFD, and is scattered throughout the Project Area.

Noxious Weeds

Once established, non-native plant species can out compete and eventually replace native species, thereby reducing forage productivity and the overall vigor of existing native plant communities. As a consequence of these effects, many non-native species are viewed as detrimental to the environment, and are regulated as such. A designated noxious weed is defined by the Wyoming Department of Agriculture as seeds or other plant parts that are considered detrimental, destructive, injurious or poisonous, either by virtue of their direct effect or as carriers of diseases or parasites that exist within this state, and are on the designated list. The State of Wyoming has designated twenty-two plant species as noxious weeds. These species are listed in Table 3–17.

Table 3–17 State of Wyoming Designated Noxious Weeds

Common Name	Scientific Name	Common Name	Scientific Name
Russian knapweed	*Acroptilon repens*	Quackgrass	*Elytrigia repens*
Skeletonleaf bursage	*Ambrosia tomentosa*	Leafy Spurge	*Euphorbia esula*
Common burdock	*Arctium minus*	Dyer's woad	*Isatis tinctoria*
Hoary cress	*Cardaria draba*	Perennial pepperweed	*Lepidium latifolium*
Plumeless thistle	*Carduus acanthoides*	Ox-eye daisy	*Leucanthemum vulgare*
Musk thistle	*Carduus nutans*	Dalmation toadflax	*Linaria dalmatica*
Diffuse knapweed	*Centaurea diffusa*	Yellow toadflax	*Linaria vulgaris*
Spotted knapweed	*Centaurea maculosa*	Purple loosestrife	*Lythrum salicaria*
Canada thistle	*Cirsium arvense*	Scotch thistle	*Onopordum acanthium*
Field Bindweed	*Convolvulus arvensis*	Perennial sowthistle	*Sonchus arvensis*
Houndstongue	*Cynoglossum officinale*	Saltcedar	*Tamarix chinensis*

Source: Wyoming Weed and Pest Council 2001.

In addition to the state noxious weed list, Campbell, Converse, Johnson, and Sheridan counties have identified other noxious weeds of concern. Noxious weeds tracked by counties within the Project Area include cocklebur (*Xanthium strumarium*), chicory (*Cichorium intybus*), Dames rocket (*Hesperis matronalis*), and common mullein (*Verbascum thapsus*).

Wyoming is experiencing the rapid introduction and spread of noxious weeds throughout the state on all lands, regardless of surface ownership. The potential for noxious weeds to continue spreading to new areas is great. As a collaborative effort, the BLM, South Goshen Cooperative Extension Conservation District, Wyoming Department of Agriculture, Natural Resources Conservation Service, and 42 private surface owners joined WGFD and Weed and Pest (W&P) District officials in the fight against noxious weeds. This group agreed to a long-term integrated weed management plan, public awareness and prevention programs, and a common inventory, while monitoring and reporting on their progress.

Noxious weeds are expected to occur throughout the Project Area. Their occurrence, distribution, and density are variable and influenced by many factors including disturbance type and frequency, climatic conditions, soil conditions, and local management efforts. Other than lists of noxious weeds maintained by the State of Wyoming and several counties, there are no additional scientific data that indicate precise areas of occurrence of any individual weed species, or noxious weeds as a whole.

Existing Disturbance

Because of past human activities in the Project Area, substantial areas of vegetation have been altered from their natural condition. Some of these alterations are included in the previous discussion of vegetation types, particularly in the agriculture and barren land cover types. Other human disturbances are typically smaller in scale and are not included in the analysis of the Project Area vegetation types. Examples of these types of disturbances include: roads, oil and gas well pads, compressor sites, and other ancillary facilities. At the time of this analysis, estimates of current disturbances related to these ancillary facilities were not available by vegetation type.

The following estimates of existing disturbances are based on the sum of existing CBM and non-CBM well disturbances within the Project Area. Estimates of existing disturbance acreage in each vegetation type by surface owner and sub-watershed are presented in Table 3–18 and Table 3–19, respectively.

Table 3–18 Existing Vegetation Disturbance by Surface Owner

	Areal Extent of Disturbance (acres)					
	BLM					
Vegetation Type	BFO	CFO	FS	State	Private	Total
Agriculture	0	0	0	40	648	688
Aspen	0	0	0	0	0	0
Barren	44	0	14	70	877	1,005
Coniferous Forest	89	0	17	28	127	261
Forest Riparian	0	0	6	0	6	12
Herbaceous Riparian	0	0	0	6	33	39
Mixed Grass Prairie	168	44	50	1,228	10,321	11,811
Other Shrublands	32	4	148	0	84	268
Sagebrush Shrublands	287	55	582	3,488	23,170	27,582
Shortgrass Prairie	908	83	919	4,062	27,034	33,006
Shrubby Riparian	0	0	0	11	182	193
Urban/Disturbed	0	0	0	0	0	0
Water	0	0	0	0	64	64
Wet Meadow	6	0	0	155	1,549	1,710
Total	1,534	186	1,736	9,088	64,095	76,639

Wetlands/Riparian Areas

Regional Characterization

Wetlands and riparian areas are unique features in the landscape occurring where aspects of soil, vegetation, and hydrology combine to form specially adapted plant communities. Due to the arid nature of the majority of the Project Area, these areas are typically restricted to major drainages, creeks, draws, lakes, and ponds. Significant water systems in the Project Area include Lake Desmet, Upper Powder River, Upper Tongue River, Upper Belle Fourche River, Clear Creek, Crazy Woman Creek, and the Upper Cheyenne River.

Table 3–19 Existing Vegetation Disturbance by Sub-watershed

	Vegetation Type (acres)														
Sub-watershed	Agriculture	Aspen	Barren	Coniferous Forest	Forest Ri-parian	Herbaceous Riparian	Mixed Grass Prairie	Other Shrublands	Sagebrush Shrublands	Shortgrass Prairie	Shrubby Ri-parian	Ur-ban/Disturbed	Water	Wet Meadow	Total
Little Bighorn River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Tongue River	306	0	193	0	0	0	1,035	0	966	1,231	130	0	21	372	4,254
Middle Fork Powder River	0	0	11	0	0	0	0	63	6	94	0	0	0	0	174
North Fork Powder River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Powder River	132	0	145	16	0	0	1,702	0	3,666	6,373	3	0	6	343	12,386
South Fork Powder River	0	0	0	61	0	0	6	81	28	0	0	0	0	0	176
Salt Creek	0	0	0	0	0	0	0	0	44	209	0	0	0	0	253
Crazy Woman Creek	0	0	0	0	0	0	69	0	308	370	0	0	0	0	747
Clear Creek	139	0	13	0	0	0	572	0	292	275	11	0	0	267	1,569
Middle Powder River	36	0	43	77	0	0	1,025	0	723	1,403	20	0	0	252	3,579
Little Powder River	46	0	161	69	0	0	3,792	0	8,369	5,336	9	0	18	322	18,122
Little Missouri River	0	0	0	0	0	0	61	0	0	11	6	0	0	6	84
Antelope Creek	6	0	22	17	12	0	139	0	1,771	5,738	0	0	0	0	7,705
Dry Fork Cheyenne River	0	0	28	0	0	17	193	0	226	149	0	0	0	0	613
Upper Cheyenne River	0	0	21	0	0	0	49	0	987	983	0	0	0	0	2,040
Lightning Creek	6	0	11	0	0	22	798	124	1,172	6	0	0	0	0	2,139
Upper Belle Fourche River	17	0	357	21	0	0	2,295	0	9,013	10,828	14	0	19	148	22,712
Middle North Platte Casper	0	0	0	0	0	0	75	0	11	0	0	0	0	0	86
Total	688	0	1,005	261	12	39	11,811	268	27,582	33,006	193	0	64	1,710	76,639

Riparian Areas

Riparian areas "develop in transitional zones between permanently saturated wetlands and upland areas. These areas exhibit vegetation or physical characteristics reflective of permanent surface or subsurface water influence" (Leonard et al. 1992). The vegetation that visually defines a riparian area is valuable in providing sediment retention, flood-flow attenuation, nutrient removal and transformation, increased production (relative to uplands) for livestock and wildlife forage, habitat diversity for aquatic terrestrial wildlife, and streambank stability. Their occurrence is generally associated with areas of flowing water. Riparian areas are an important resource on public lands and are managed as such (Almand and Krohn 1978; BLM 1991). Although riparian areas often contain wetlands, they also may contain areas that do not meet federal definitions of jurisdictional wetlands. Likewise, not all wetland areas are associated with riparian ecosystems. Table 3–15 and Table 3–16 present the occurrence and relative distribution of riparian areas in the Project Area.

Wetlands

Wetlands are landscape features that are delineated on the basis of specific soil, vegetation, and hydrologic conditions. A wetland is defined as an area typically flooded or saturated with sufficient frequency and/or duration, with surface water or groundwater, that these areas mostly support vegetation adapted for growth in soils that are saturated under normal circumstances (40 Code of Federal Regulations [CFR] 230). Wetlands typically include swamps, marshes, bogs, and similar areas. Waters of the U.S. is a collective term for all areas subject to regulation by the U.S. Army Corps of Engineers (COE) under Section 404 of the Clean Water Act. Waters of the U.S. within the Project Area may include: intermittent and ephemeral draws, creeks, and rivers. As the result of the recent Supreme Court ruling (Solid Waste Agency of Northern Cook County *v*. United States Army Corps of Engineers, January 9, 2001) non-navigable, isolated intrastate wetlands and other Waters of the U.S. within the Project Area are not considered jurisdictional. Navigable, non-isolated wetlands and other Waters of the U.S. are still considered jurisdictional by the COE.

Wetlands can occur in a variety of forms within the Project Area. Riverine wetlands, defined by their close association with perennial streams, occur sporadically along drainages within the Project Area. These areas are supported not only by the groundwater associated with the drainage, but by periodic flooding events. Common species in these settings can include willows (*Salix* spp.), scouring rush (*Equisetum* spp.), sedges (*Carex* spp.), and rushes (*Juncus* spp.) (FS 1987).

Topographical depressions that are naturally subirrigated support palustrine wetlands. Palustrine wetlands are commonly referred to as wet meadows and can support a variety of lush plant life. Lacustrine wetlands can also occur in topographical depressions. Naturally occurring lacustrine wetlands are often referred to as playa lakes. Conditions similar to those found in playa lakes can also be created by man-made structures such as stock ponds. Common plant species that can occur in these depressional wetlands include cattails (*Typha* spp.), bulrush (*Scirpus* spp.), sedges, rushes, cordgrass (*Spartina* spp.), mint (*Mentha* spp.), buttercup (*Ranunculus* spp.), lady's thumb (*Polygonum* spp.), verbena (*Verbena* spp.), and milkweed (*Asclepias* spp) (Pruiett 1998; FS 1987). Table 3–15 and Table 3–16 present the occurrence and relative distribution of riparian areas in the Project Area drainages; wetlands within the Project Area are assumed to be a portion of the riparian areas shown in these tables.

Wildlife

Regional Characterization

The wildlife species identified as part of the issues in the scoping process that inhabit the study area represent the following groups: big game, raptors, upland game birds, and waterfowl. Aquatic resources in the Project Area occur within major drainage systems, such as rivers, streams, minor creeks, draws, and playa lakes, and ponds. The following sections present information regarding the major wildlife groups common to terrestrial and aquatic environments in the Project Area.

Terrestrial Species

Wildlife Habitats

All of the vegetation types listed in the vegetation section provide habitat for some wildlife species. In an undisturbed condition, the major vegetation types in the Project Area provide high quality habitats for many wildlife species. Because these habitats tend to occur in a mosaic across the landscape, many wildlife species can be expected to utilize more than one habitat. The following paragraphs list some of the wildlife species that can be found in the common vegetation types in the Project Area, although these species may also be found in other habitat types if the necessary habitat components are available.

Common wildlife species that typically occur in shortgrass and mixed-grass prairie habitats include prairie rattlesnake (*Crotalus viridis*), golden eagle (*Asguila chrysaetos*), prairie falcon (*Falco mexicanus*), ferruginous hawk (*Buteo regalis*), Swainson's hawk (*Buteo swainsoni*), lark bunting (*Calamospiza melanocorys*), horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), lark sparrow (*Chondestes grammacus*), vesper sparrow (*Pooecetes gramineus*), badger (*Taxidea taxus*), coyote (*Canis latrans*), swift fox (*Vulpes velox*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), black-tailed jackrabbit (*Lepus californicus*), Ord's kangaroo rat (*Dipodomys ordii*), deer mouse (*Peromyscus maniculatus*), western harvest mouse (*Reithrodontomys megalotis*), plains pocket gopher (*Geomys bursarius*), black-tailed prairie dog (*Cynomys ludovicianus*), and pronghorn (*Antilocapra americana*).

Common wildlife species that may occur in sagebrush shrublands include: eastern short-horned lizard (*Phrynosoma douglassi brevirostre*), prairie rattlesnake, northern harrier, Swainson's hawk, sage grouse (*Centrocercus urophasianus*), Say's phoebe (*Sayornis saya*), western kingbird (*Tyrannus verticalis*), horned lark, sage thrasher (*Oreoscoptes montanus*), Brewer's sparrow (*Spizella breweri*), vesper sparrow, sage sparrow (*Amphispiza belli*), McCown's longspur (*Calcarius mccownii*), western meadowlark, desert cottontail (*Sylvilagus auduboni*), black-tailed jackrabbit, thirteen-lined ground squirrel, northern pocket gopher (*Thomomys talpoides*), Ord's kangaroo rat, deer mouse, and prairie vole (*Microtus ochrogaster*).

Common wildlife species that may occur in other shrublands are similar to those that inhabit sagebrush shrublands, and include: garter snake (*Thamnophis elegans*), chukar (*Alectoris chukar*), sharp-tailed grouse (*Tympanuchus phasianellus*), western kingbird, horned lark, black-billed magpie (*Pica pica*), rock wren (*Salpinctes obsoletus*), sage thrasher, lazuli bunting (*Passerina amoena*), spotted towhee (*Pipilo maculates*), Brewer's sparrow, lark sparrow, lark bunting, bobolink (*Dolichonyx oryzivorus*), masked shrew (*Sorex cinereus*), desert cottontail, least chipmunk (*Tamias minimus*), Wyoming ground squirrel (*Spermophilus elegans*), thirteen-lined ground squirrel, deer mouse, northern grasshopper mouse (*Onychomys leucogaster*), coyote, western spotted skunk (*Spilogale gracilis*), and mule deer (*Odocoileus hemionus*).

Wildlife species that may occur in riparian areas (including herbaceous, shrubby, and forested riparian areas) include: bullsnake (*Pituophis catenifer*), tiger salamander (*Ambystoma tigrinum*), northern leopard frog (*Rana pipiens*), northern harrier (*Circus cyaneus*),Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), common snipe (*Gallinago gallinago*), short-eared owl (*Asio flammeus*), marsh wren (*Cistothorus palustris*), common yellowthroat (*Geothlypis trichas*), savannah sparrow (*Passerculus sandwhichensis*), song sparrow (*Melopsiza melodia*), red-winged blackbird (*Agelaius phoeniceus*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*), deer mouse, meadow vole (*Microtus pennsylvanicus*), and red fox (*Vulpes vulpes*). Wet meadows tend to provide habitats for wildlife species associated with nearby dominant vegetation cover types (such as prairie or sagebrush shrublands), although in areas of large wet meadow complexes species common to riparian habitats may also occur.

Although they occur only sporadically throughout the Project Area, coniferous woodlands support a different set of wildlife species than other habitat types, primarily due to seed production and potential nest substrates provided by the various conifer species. Common wildlife species in coniferous forest include: mountain chickadee (*Parus gambeli*), mourning dove (*Zenaida macroura*), golden eagle, mountain bluebird (*Sialia currucoides*), northern flicker (*Colaptes auratus*), western tanager (*Piranga ludoviciana*), pinyon jay (*Gymnorhinus cyanocephalus*), chipping sparrow (*Spizella passerina*), lark sparrow, Nuttall's cottontail (*Sylvilagus nuttallii*), mule deer, gray fox (*Urocyon cinereoargenteus*), black-tailed jackrabbit, porcupine (*Erethizon dorsatum*), bushy-tailed woodrat (*Neotoma cinerea*), and mountain lion (*Felis concolor*).

Big Game

Big game species that are expected to occur in suitable habitats throughout the Project Area include pronghorn (*Antilocapra americana*), white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), and moose (*Alces alces*). Nomenclature follows Jones et al. (1997).

WGFD has identified various ranges for big game species. These ranges are defined as:

- Crucial Range (CRU): any particular seasonal range or habitat component, but describes that component which has been documented as the determining factor in a population's ability to maintain and reproduce itself at a certain level.
- Summer or Spring-Summer-Fall (SSF): A population or portion of a population of animals use the documented habitats within this range annually from the end of previous winter to the onset of persistent winter conditions.
- Severe Winter Relief (SWR): A documented survival range which may or may not be considered a crucial range area as defined above. It is used to a great extent, only in occasionally extremely severe winters. It may lack habitat characteristics that would make it attractive or capable of supporting major portions of the population during normal years but is used by and allows at least a significant portion of the population to survive the occasional extremely severe winter.
- Winter (WIN): A population or portion of a population of animals use the documented suitable habitat sites within this range annually, in substantial numbers only during the winter period.
- Winter/Yearlong (WYL): A population or a portion of a population of animals makes general use of the documented suitable habitat sites within this range on a year-round basis. During the winter months there is a significant influx of additional animals into the area form other seasonal ranges.
- Yearlong (YRL): A population or substantial portion of a population of animals makes general use of the suitable documented habitat sites within the range on a year-round basis. Animals may leave the area under severe conditions on occasion.
- Parturition Areas (PAR): Documented birthing areas commonly used by females. It includes calving areas, fawning areas and lambing grounds. These areas may be used as nurseries by some big game species.

Pronghorn

Pronghorn typically inhabit grasslands and semi-desert shrublands of the western and southwestern United States. This species is most abundant in short- and mixed-grass habitats and is less abundant in more xeric habitats. Home range for pronghorn can vary between 400 acres to 5,600 acres, according to several factors including season, habitat quality, population characteristics, and local livestock occurrence. Typically, daily movement does not exceed six miles. Pronghorn make seasonal migrations between summer and winter habitats, but are often triggered by availability of succulent plants and not local weather conditions (Fitzgerald et al. 1994). Wyoming supports the largest population of pronghorn in North America (Clark and Stromberg 1987).

WGFD has delineated pronghorn into herd units to estimate population sizes. The following herd units reside entirely or partially within the Project area: 308, 309, 310, 316, 318, 339, 351, 352, 353, 354, 742, 747, and 748.

Pronghorn antelope occur in most areas throughout the Project Area, except in the foothills in the western margin of the central portion of the Project Area (Figure 3–10). The type and distribution of pronghorn ranges by land ownership and sub-watersheds are presented in Table 3–20 and Table 3–21, respectively. Figure 3–10 depicts pronghorn ranges within the Project Area. Existing human disturbances within the Project Area, as previously discussed, have altered many of the habitats used by pronghorn.

Table 3–20 Pronghorn Ranges by Surface Owner

	BLM					
Range	Buffalo Field Office	Casper Field Office	Forest Service	State	Private	Total
Severe Winter	0	0	33,590	3,197	14,181	50,968
Crucial Winter Yearlong	0	77	0	0	68	145
Winter	22,563	0	0	11,815	122,583	156,961
Winter Yearlong	97,239	39,897	37,230	131,058	1,488,113	1,793,537
Yearlong	385,467	46,550	195,488	405,163	3,643,583	4,676,250
Spring, Summer, Fall	28,023	7,359	0	14,357	73,738	123,477
Total	533,292	93,883	266,308	565,590	5,342,266	6,801,338

Table 3–21 Pronghorn Ranges by Sub-watershed

	Pronghorn Ranges (acres)						
Sub-watershed	Severe Winter	Crucial Winter	Winter	Winter Yearlong	Yearlong	Spring, Summer, Fall	Total
Little Bighorn River	0	0	0	0	1,010	0	1,010
Upper Tongue River	0	0	0	13,095	527,241	0	540,336
Middle Fork Powder River	0	0	0	118,113	42,363	59,888	220,364
North Fork Powder River	0	0	0	0	18,285	801	19,086
Upper Powder River	0	0	23,728	470,784	854,525	132	1,349,169
South Fork Powder River	0	0	0	57	114,153	0	114,210
Salt Creek	0	0	0	17,866	104,144	17,816	139,826
Crazy Woman Creek	0	0	0	36,566	446,038	18,580	501,184
Clear Creek	0	0	0	37,931	442,750	1,196	481,878
Middle Powder River	0	0	67,048	0	124,445	24,841	216,334
Little Powder River	0	0	66,185	218,720	446,055	0	730,960
Little Missouri River	0	0	0	6,406	27,559	0	33,964
Antelope Creek	31,773	0	0	57,525	570,722	222	660,242
Dry Fork Cheyenne River	19,195	0	0	83,173	206,951	0	309,320
Upper Cheyenne River	0	0	0	62,976	115,764	0	178,740
Lightning Creek	0	0	0	58,831	249,494	0	308,325
Upper Belle Fourche River	0	0	0	491,029	292,788	0	783,817
Middle North Platte Casper	0	145	0	120,467	91,964	0	212,576
Total	50,968	145	156,961	1,793,539	4,676,251	123,476	6,801,341

Figure 3–10 Pronghorn Ranges

WGFD has estimated the population size all of herd units within the Project Area to be 108,802 (Rothwell 2001). This number excludes data from herd units 742 and 747, which were unavailable.

The overall population trend of pronghorn in the Project area has increased and stabilized. In general, herd units have reached WGFD population objectives. As of 2000, the average herd unit population is 26.2 percent above the population objective (Rothwell 2001).

Because of past human activities in the Project Area, substantial areas of pronghorn ranges have been altered from their natural conditions. Human disturbances include, but are not limited to agriculture, mining, roads, urban areas, oil and gas well pads, compressor sites, and other ancillary facilities. Table 3–22 and Table 3–23 present existing disturbance to pronghorn ranges by owner and sub-watershed, respectively.

Table 3–22 Existing Pronghorn Disturbance by Surface Owner

	Surface Owners (acres)					
	BLM					
Range	BFO	CFO	FS	State	Private	Total
Severe Winter	0	0	60	10	70	140
Winter	149	0	0	497	2,196	2,841
Winter Yearlong	544	100	757	4,194	38,125	43,721
Yearlong	1,294	240	1,895	7,685	47,985	59,099
Spring, Summer, Fall	128	0	0	116	355	599
Total	2,115	340	2,712	12,502	88,731	106,400

White-tailed Deer

White-tailed deer occur throughout North America from the southern United States to the Hudson Bay in Canada. Across much of its range, this species utilizes forests, swamps, brushy areas, and nearby open fields. In Wyoming, the white-tailed deer are found throughout the state typically concentrated in riparian woodlands, shrubby riparian and associated irrigated agricultural lands and absent from dry grasslands and coniferous forests (Clark and Stromberg 1987). Their diet is diverse, capitalizing on the most nutritious plant matter available at any particular time. In addition to native browse, grass, and forbs, this species will rely on agricultural crops, fruits, acorns and other nuts. White-tailed deer mortality is typically due to hunting, winter starvation, collisions with automobiles, and predation. Predators may include coyotes, mountain lions, wolves, and, occasionally, bears, bobcats and eagles (Fitzgerald et al. 1994).

In the Project Area, white-tailed deer occurrence is restricted to river and stream drainages and riparian habitats associated with the northern foothills of the Bighorn Mountains. They tend to be absent from large expanses of prairie and shrubland. The type and distribution of white-tailed deer ranges within sub-watersheds and by land ownership are presented in Table 3–24 and Table 3–25, respectively. Figure 3–11 depicts white-tailed deer ranges within the Project Area. The distribution of white-tailed deer ranges by vegetation type is presented in Table 3–26.

Table 3–23 Existing Pronghorn Disturbance by Sub-watershed

Sub-watershed	Pronghorn Ranges (acres) Severe Winter	Winter	Winter Yearlong	Yearlong	Spring, Summer, Fall	Total
Little Bighorn River	0	0	0	0	0	0
Upper Tongue River	0	0	1,407	3,953	0	5,359
Middle Fork Powder River	0	0	270	0	0	270
North Fork Powder River	0	0	0	0	0	0
Upper Powder River	0	1,655	6,523	7,404	0	15,581
South Fork Powder River	0	0	0	260	0	260
Salt Creek	0	0	10	230	0	240
Crazy Woman Creek	0	0	0	1,015	0	1,015
Clear Creek	0	0	0	2,049	0	2,049
Middle Powder River	0	1,000	0	3,240	599	4,839
Little Powder River	0	187	10,785	13,526	0	24,498
Little Missouri River	0	0	70	70	0	140
Antelope Creek	80	0	1,273	9,693	0	11,046
Dry Fork Cheyenne River	60	0	290	760	0	1,110
Upper Cheyenne River	0	0	1,104	1,294	0	2,398
Lightning Creek	0	0	1,140	2,660	0	3,800
Upper Belle Fourche River	0	0	20,799	11,344	0	32,142
Middle North Platte Casper	0	0	50	87	0	137
Total	140	2,841	43,721	57,583	599	104,884

Table 3–24 Distribution of White-tailed Deer Ranges by Sub-watershed

Sub-watershed	Ranges (acres) Winter Yearlong	Yearlong	Total
Little Bighorn River	0	16,475	16,475
Upper Tongue River	0	265,929	265,929
Middle Fork Powder River	0	31,635	31,635
North Fork Powder River	0	0	0
Upper Powder River	0	71,096	71,096
South Fork Powder River	0	9,383	9,383
Salt Creek	0	321	321
Crazy Woman Creek	0	67,473	67,473
Clear Creek	0	130,990	130,990
Middle Powder River	4,671	12,554	17,225
Little Powder River	0	102,407	102,407
Little Missouri River	0	4,681	4,681
Antelope Creek	0	17,986	17,986
Dry Fork Cheyenne River	0	11,681	11,681
Upper Cheyenne River	0	0	0
Lightning Creek	0	4,731	4,731
Upper Belle Fourche River	0	13,633	13,633
Middle North Platte Casper	0	0	0
Total	4,671	760,976	765,647

Figure 3–11 White-tailed Deer Ranges

Table 3–25 Distribution of White-tailed Deer Ranges by Surface Owner

	Surface Owner (acres)					
	BLM					
Range	BFO	CFO	FS	State	Private	Total
Winter Yearlong	259	0	0	515	3,898	4,671
Yearlong	22,410	1,059	5,054	69,220	663,229	760,972
Total	22,669	1,059	5,054	69,735	667,127	765,643

Table 3–26 Distribution of White-tailed Deer Ranges by Vegetation Type

	White-tail Deer Ranges (acres)	
Vegetation Type	Winter Yearlong	Yearlong
Agriculture	0	79,001
Barren	91	10,121
ConiferousForest	473	90,34
ForestedRiparian	0	5,647
HerbaceousRiparian	0	2,281
MixedGrassPrairie	1,818	242,604
OtherShrublands	0	13,730
SagebrushShrublands	382	133,547
ShortgrassPrairie	1,469	161,213
ShrubbyRiparian	11	340,44
Water	0	2,367
WetMeadow	428	67,395

As a result of past human activities in the Project Area, substantial areas of white-tailed deer ranges have been altered from their natural conditions. Human disturbances include, but are not limited to, agriculture, mining, roads, urban areas, oil and gas well pads, compressor sites, and other ancillary facilities. Table 3–27 and Table 3–28 present existing disturbance to white-tailed deer ranges by owner and sub-watershed, respectively.

Table 3–27 Existing White-tailed Deer Disturbance by Surface Owner

	Surface Owner (acres)					
	BLM					
Range	BFO	CFO	FS	State	Private	Total
Yearlong	69	0	0	1,244	6,741	8,053
Total	69	0	0	1,244	6,741	8,053

Table 3–28 Existing White-tailed Deer Disturbance by Sub-watershed

	White-tailed Deer Range (acres)	
Sub-watershed	Yearlong	Total
Little Bighorn River	0	0
Upper Tongue River	3,065	3,065
Middle Fork Powder River	30	30
North Fork Powder River	0	0
Upper Powder River	1,695	1,695
South Fork Powder River	0	0
Salt Creek	0	0
Crazy Woman Creek	868	868
Clear Creek	1,059	1,059
Middle Powder River	39	39
Little Powder River	853	853
Little Missouri River	0	0
Antelope Creek	50	50
Dry Fork Cheyenne River	30	30
Upper Cheyenne River	0	0
Lightning Creek	30	30
Upper Belle Fourche River	331	331
Middle North Platte Casper	0	0
Total	8,050	8,050

Mule Deer

Mule deer occur throughout western North America from central Mexico to northern Canada. Typical habitats include shortgrass and mixed grass prairies, sagebrush and other shrublands, coniferous forests, and forested and shrubby riparian areas. In Wyoming, mule deer occur in mountains and associated foothills, broken hill country, and prairie grasslands and shrublands (Clark and Stromberg 1987). Browse is an important component of the mule deer's diet throughout the year, comprising as much as 60 percent of total intake during autumn, while forbs and grasses typically make up the rest of their diet (Fitzgerald et al. 1994). This species tends to be more migratory than white-tailed deer, traveling from higher elevations in the summer to winter ranges that provide more food and cover. Fawn mortality is typically due to predation or starvation. Adult mortality often occurs from hunting, winter starvation, and automobile collisions. Typical predators may include coyotes, bobcats, golden eagles, mountain lions, bears, and domestic dogs (Fitzgerald et al. 1994).

WGFD has delineated mule deer into herd units to estimate population. The following herd units reside entirely or partially within the Project area: 319, 320, 321, 322, 752, 753, and 755.

In the Project Area, mule deer ranges occur in nearly all areas, except in several areas located approximately between Wright and Gillette. The type and distribution of mule deer ranges within sub-watersheds and by land ownership are presented Table 3–29 and Table 3–30**,** respectively. Figure 3–12 depicts mule deer ranges within the Project Area. The distribution of mule deer ranges by vegetation type is presented in Table 3–31.

Table 3–29 Mule Deer Ranges by Surface Owner

	Surface Owner (acres)					
	BLM					
Range	BFO	CFO	FS	State	Private	Total
Winter Yearlong	542,496	19,846	73,846	352,432	2,842,439	3,831,058
Yearlong	211,891	74,036	164,125	231,770	2,552,761	3,234,584
Spring, Summer, Fall	25,481	0	0	13,629	88,627	127,738
Total	779,868	93,883	237,970	597,832	5,483,827	7,193,380

Table 3–30 Mule Deer Ranges by Sub-watershed

	Ranges (acres)			
Sub-watershed	Spring, Summer, Fall	Winter Yearlong	Yearlong	Total
Little Bighorn River	1,427	44,368	3,790	49,585
Upper Tongue River	8,091	589,648	135,813	733,552
Middle Fork Powder River	101,252	341,123	22,080	464,455
North Fork Powder River	1,824		18,851	20,675
Upper Powder River	0	950,809	611,233	1,562,042
South Fork Powder River	0	75,344	39,012	114,356
Salt Creek	0	71,512	73,308	144,820
Crazy Woman Creek	13,373	368,633	166,283	548,289
Clear Creek	1,852	466,860	78,159	546,871
Middle Powder River	0	158,916	65,316	224,232
Little Powder River	0	468,758	291,841	760,599
Little Missouri River	0	37,106	1,422	38,528
Antelope Creek	0	68,433	517,320	585,753
Dry Fork Cheyenne River	0	67,233	242,087	309,320
Upper Cheyenne River	0	1,502	142,947	144,449
Lightning Creek	0	49,550	258,775	308,325
Upper Belle Fourche River	0	7,954	425,028	432,982
Middle North Platte Casper	0	64,082	148,493	212,575
Total	127,819	3,831,832	3,241,758	7,201,409

WGFD has estimated the population size of all herd units within the Project Area to be 157,128 (Rothwell 2001). This number excludes data from herd units 754, which was unavailable.

The overall population trend of mule deer in the Project area has increased and stabilized. In general, herd units have reached WGFD population objectives. As of 2000, the average herd unit population is 15.7 percent above the population objective (Rothwell 2001).

Table 3–31 Distribution of Mule Deer Ranges by Vegetation Type

	Mule Deer Ranges (acres)		
Vegetation Type	Winter Yearlong	Yearlong	Spring, Summer, Fall
Agriculture	74,475	37,727	0
Aspen	3	0	68
Barren	59,803	44,277	632
Coniferous Forest	118,778	41,538	31,044
Forested Riparian	7,910	3,159	394
Herbaceous Riparian	10,191	2,079	67
Mixed Grass Prairie	911,071	526,683	39,527
Other Shrublands	128,796	36,680	12,407
Sagebrush Shrublands	872,263	1,033,811	33,402
Short-grass Prairie	1,469,575	1,473,443	7,766
Shrubby Riparian	48,794	7,178	1,502
Urban/Disturbed	1,744	2,618	0
Water	4,662	3,872	87
Wet Meadow	124,575	27,909	923

Because of past human activities in the Project Area, substantial areas of mule deer ranges have been altered from their natural conditions. Human disturbances include, but are not limited to, agriculture, mining, roads, urban areas, oil and gas well pads, compressor sites, and other ancillary facilities. Table 3–32 and Table 3–33 present existing disturbances to pronghorn ranges by owner and sub-watershed, respectively.

Table 3–32 Existing Mule Deer Disturbance by Surface Owner

	Surface Owner (acres)					
	BLM					
Range	BFO	CFO	FS	State	Private	Total
Winter Yearlong	1,183	90	280	3,590	20,649	25,792
Yearlong	1,007	275	1,050	5,624	44,116	52,073
Total	2,190	365	1,330	9,215	64,765	77,864

Figure 3–12 Mule Deer Ranges

Table 3–33 Existing Mule Deer Disturbance by Sub-watershed

	Mule Deer Range (acres)		
Sub-watershed	Winter Yearlong	Yearlong	Total
Little Bighorn River	0	0	0
Upper Tongue River	5,460	27	5,487
Middle Fork Powder River	270	0	270
North Fork Powder River	0	0	0
Upper Powder River	10,008	7,289	17,297
South Fork Powder River	240	20	260
Salt Creek	100	200	300
Crazy Woman Creek	81	934	1,015
Clear Creek	1,104	1,026	2,130
Middle Powder River	3,604	1,369	4,973
Little Powder River	3,390	16,593	19,984
Little Missouri River	165	0	165
Antelope Creek	215	5,655	5,870
Dry Fork Cheyenne River	320	790	1,110
Upper Cheyenne River	0	1,437	1,437
Lightning Creek	840	2,960	3,800
Upper Belle Fourche River	0	13,551	13,551
Middle North Platte Casper	10	127	137
Total	25,807	51,978	77,786

Elk

Elk formerly ranged over much of central and western North America from the southern Canadian Provinces and Alaska south to the southern United States, and eastward into the deciduous forests. In Wyoming, this species occurs throughout the state occupying a variety of habitats including coniferous forests, mountain meadows, short- and mixed-grass prairies and, sagebrush and other shrublands. Similar to other members of the deer family, this species relies on a combination of browse, grasses and forbs depending on their availability throughout the seasons. Elk tend to be migratory, moving between summer and winter ranges. Typically, mortality is often due to predation on calves, hunting, and winter starvation. Predators may include coyotes, mountain lions, bobcats, bears, and golden eagles.

WGFD has estimated the population size of all herd units within the Project Area to be 11,787 (Rothwell 2001).

The overall population trend of elk in the Project Area has increased and stabilized. In general, herd units have reached WGFD population objectives. As of 2000, the average herd unit population is 74.4 percent above the population objective (Rothwell 2001).

In the Project Area, elk ranges are concentrated in the Bighorn Mountains and asoociated foothills, the Fortification Creek Area that is west of Gillette, and north of I-90 in the center of the Project Area, Medicine Bow Mountains in the south, and Black Hills in the southeast. The type and distribution of elk ranges within sub-watersheds and by land ownership are presented in Table 3–34 and Table 3–35**,** respectively. Figure 3–13 depicts elk ranges within the Project Area. The distribution of elk ranges by vegetation type is presented in Table 3–36.

Table 3–34 Distribution of Elk Ranges (excluding Fortification Creek) by Surface Ownership

	Surface Owner (acres)					
	BLM					
Range	BFO	CFO	FS	State	Private	Total
Crucial Winter	923	0	4,592	5,937	36,979	48,431
Crucial Winter Yearlong	40,783	0	0	11,944	52,200	104,927
Spring, Summer, Fall	17,646	0	0	11,670	75,994	105,310
Winter	140	0	0	2,929	8,755	11,824
Winter Yearlong	3,388	0	21,438	3,660	16,756	45,242
Yearlong	45,744	18,063	38,966	22,777	168,938	294,489
Total	108,624	18,063	64,996	58,917	359,622	610,223

Table 3–35 Elk Ranges (excluding Fortification Creek) by Sub-watershed

	Elk Range (acres)						
Sub-watershed	Crucial Winter	Crucial Winter Yearlong	Spring, Summer, Fall	Winter	Winter Yearlong	Yearlong	Total
Little Bighorn River	4,734	266	1,752	33	2,563	0	9,347
Upper Tongue River	26,992	0	10,266	842	10	0	38,110
Middle Fork Powder River	0	88,623	43,725	0	745	85,917	219,011
North Fork Powder River	0	0	8,490	0	0	12,185	20,675
Upper Powder River	0	0	0	0	0	15,346	15,346
South Fork Powder River	0	0	0	0	0	16,929	16,929
Salt Creek	0	0	0	0	0	19,303	19,303
Crazy Woman Creek	0	16,039	34,760	1,616	10,170	0	62,586
Clear Creek	9,980	0	6,416	9,350	0	0	25,745
Middle Powder River	0	0	0	0	0	0	0
Little Powder River	0	0	0	0	0	0	0
Little Missouri River	0	0	0	0	0	0	0
Antelope Creek	3,401	0	0	0	21,472	61,189	86,062
Dry Fork Cheyenne River	0	0	0	0	597	4,339	4,936
Upper Cheyenne River	3,390	0	0	0	9,700	68,814	81,904
Lightning Creek	0	0	0	0	0	0	0
Upper Belle Fourche River	0	0	0	0	0	10,466	10,466
Middle North Platte Casper	0	0	0	0	0	0	0
Total	48,497	104,928	105,409	11,841	45,257	294,488	610,420

Figure 3–13 Elk Ranges

Table 3–36 Distribution of Elk Ranges by Vegetation Type

	Elk Ranges (acres)						
Vegetation Type	Crucial Winter Yearlong	Crucial Winter	Winter	Winter Yearlong	Year long	Spring, Summer, Fall	Unde-termined
Agriculture	0	795	22	0	0	6	6,218
Aspen	0	1	0	2	0	68	0
Barren	1,104	8	0	762	4,092	63	175
Coniferous Forest	23,674	7,698	3,905	6,004	36,823	43,185	29
Forested Riparian	60	1,385	202	460	772	2,892	1,333
Herbaceous Riparian	11	47	25	12	70	49	4,220
Mixed-grass Prairie	33,228	14,918	3,990	6,090	42,884	24,286	37,382
Other Shrublands	16,230	273	111	9	23,507	4,590	21,478
Sagebrush Shrublands	18,396	8,947	2,469	10,784	69,706	24,079	121,606
Short-grass Prairie	11,839	4,378	166	19,672	113,328	1,507	6,970
Shrubby Riparian	347	7,472	690	1,091	133	3,125	0
Water	0	108	25	56	219	87	0
Wet Meadow	40	2,466	237	315	2,955	1,472	0

Because of past human activities in the Project Area, some areas of elk ranges have been altered from their natural conditions. Human disturbances include, but are not limited to, agriculture, mining, roads, urban areas, oil and gas well pads, compressor sites, and other ancillary facilities. Table 3–37 and Table 3–38 present existing disturbances to elk ranges by owner and sub-watershed, respectively.

Table 3–37 Existing Elk Disturbance (excluding Fortification Creek) by Surface Owner

	Surface Owner (acres)					
	BLM					
Range	BFO	CFO	FS	State	Private	Total
Yearlong	200	0	200	50	250	700
Crucial Winter Yearlong	0	0	0	0	0	0
Crucial Winter	0	0	100	0	0	100
Winter Yearlong	0	0	150	20	50	220
Total	200	0	450	70	30	1,020

Table 3–39 and Table 3–40 present the distribution of Fortification Creek elk ranges by surface owner and sub-watershed, respectively. Table 3–41 and Table 3–42 present existing disturbance to elk ranges in Fortification Creek by surface owner and sub-watershed.

Table 3–38 Existing Elk Disturbance (excluding Fortification Creek) by Sub-watershed

Sub-watershed	Yearlong	Crucial Winter Yearlong	Crucial Winter	Winter Year-long	Total
Little Bighorn River	0	0	0	0	0
Upper Tongue River	0	0	0	0	0
Middle Fork Powder River	0	0	0	0	0
North Fork Powder River	0	0	0	0	0
Upper Powder River	60	0	0	0	60
South Frk Powder River	260	0	0	0	260
Salt Creek	0	0	0	0	0
Crazy Woman Creek	0	0	0	0	0
Clear Creek	0	0	0	0	0
Middle Powder River	0	0	0	0	0
Little Powder River	0	0	0	0	0
Little Missouri River	0	0	0	0	0
Antelope Creek	190	0	100	210	500
Dry Fork Cheyenne River	0	0	0	0	0
Upper Cheyenne River	190	0	0	10	200
Lightning Creek	0	0	0	0	0
Upper Belle Fourche River	0	0	0	0	0
Middle North Casper River	0	0	0	0	0
Total	700	0	100	220	1,020

Table 3–39 Elk Ranges (Fortification Creek only) by Surface Owner

	Surface Owner (acres)					
	BLM					
Range	BFO	CFO	FS	State	Private	Total
Critical Winter	15,772	0	0	2,242	20,219	38,234
PAR	27,857	0	0	3,330	28,105	59,292
Winter Yearlong	33,235	0	0	4,504	33,415	71,155
Yearlong	54,265	0	0	7,689	60,977	122,931

Table 3–40 Elk Ranges (Fortification Creek only) by Sub-watershed

	Ranges (acres)			
Sub-watershed	Critical Winter	PAR	Winter Yearlong	Yearlong
Little Bighorn River	0	0	0	0
Upper Tongue River	0	0	0	0
Middle Fork Powder River	0	0	0	0
North Fork Powder River	0	0	0	0
Upper Powder River	38,234	59,292	71,155	122,931
South Fork Powder River	0	0	0	0
Salt Creek	0	0	0	0
Crazy Woman Creek	0	0	0	0
Clear Creek	0	0	0	0
Middle Powder River	0	0	0	0
Little Powder River	0	0	0	0
Little Missouri River	0	0	0	0
Antelope Creek	0	0	0	0
Dry Fork Cheyenne River	0	0	0	0
Upper Cheyenne River	0	0	0	0
Lightning Creek	0	0	0	0
Upper Belle Fourche River	0	0	0	0
Middle North Casper River	0	0	0	0
Total	38,234	59,292	71,155	122,931

Note: Range acreages overlap with each other. Thus, it is not appropriate to sum across categories.

Table 3–41 Existing Elk Disturbance (Fortification Creek) by Surface Owner

	Surface Owner (acres)					
	BLM					
Range	BFO	CFO	FS	State	Private	Total
Yearlong	0	0	0	0	10	10
Crucial Winter Yearlong	10	0	0	0	19	29
Crucial Winter	44	0	0	26	75	144
Winter Yearlong	68	0	0	58	419	546
Total	122	0	0	84	523	728

Moose

In North America, moose occur from Alaska to the northeastern United States and south along the Rocky Mountains into Colorado. In Wyoming, this species occurs in the western half and isolated southern areas of the state. Typical moose habitats in the Rocky Mountains include willow, spruce, fir, aspen, or birch.

These habitats are common to forested riparian, shrubby riparian, and wet meadow vegetation types. Willow is an important dietary component on all seasonal ranges, especially winter range when grasses, forbs, and aquatic vegetation are less available. Moose tend to have strong affinity for specific home ranges, but will make seasonal migrations in search of suitable forage and habitat. Major mortality factors include hunting, starvation, and predation. Common predators include mountain lion, wolverine, coyote, bear, lynx, and domestic dog (Fitzgerald et al. 1994).

Table 3–42 Existing Elk Disturbance (Fortification Creek) by Sub-watershed

Sub-watershed	Yearlong	Crucial Winter Yearlong	Crucial Winter	Winter Yearlong	Total
Little Bighorn River	0	0	0	0	0
Upper Tongue River	0	0	0	0	0
Middle Fork Powder River	0	0	0	0	0
North Fork Powder River	0	0	0	0	0
Upper Powder River	546	29	10	142	727
South Frk Powder River	0	0	0	0	0
Salt Creek	0	0	0	0	0
Crazy Woman Creek	0	0	0	0	0
Clear Creek	0	0	0	0	0
Middle Powder River	0	0	0	0	0
Little Powder River	0	0	0	0	0
Little Missouri River	0	0	0	0	0
Antelope Creek	0	0	0	0	0
Dry Fork Cheyenne River	0	0	0	0	0
Upper Cheyenne River	0	0	0	0	0
Lightning Creek	0	0	0	0	0
Upper Belle Fourche River	0	0	0	0	0
Middle North Casper River	0	0	0	0	0
Total	546	29	10	142	727

Moose ranges are extremely limited within the Project Area. In the Project Area ,moose ranges are restricted to areas along the western project boundary in the Bighorn Mountains. In the Rocky Mountains, moose typically rely upon a mixture of willow, spruce, fir, aspen, or birch. The type and distribution of moose ranges within sub-watersheds and by land ownership are presented in Table 3–43 and Table 3–44**,** respectively. Figure 3–14 depicts moose ranges within the Project Area. The distribution of moose ranges by vegetation type is presented in Table 3–45.

No existing disturbance for moose habitats occurs within the Project Area.

Table 3–43 Distribution of Moose Ranges by Surface Ownership

	Surface Owner (acres)				
	BLM				
Range	BFO	CFO	FS	State	Private
Crucial Winter Yearlong	9	0	0	100	832
Crucial Yearlong	0	0	1	0	138
Undetermined/Undocumented	0	0	0	7	609
Winter Yearlong	0	0	0	169	1,634
Yearlong	0	0	1	285	2,772
Total	9	0	2	561	5,985

Table 3–44 Distribution of Moose Ranges by Sub-watershed

	Moose Ranges (acres)				
Sub-watershed	Crucial Winter Yearlong	Crucial Yearlong	Undetermined/ Undocumented	Winter Yearlong	Yearlong
Little Bighorn River	0	0	0	0	420
Upper Tongue River	940	139	0	1,473	2,161
Middle Fork Powder River	0	0	9	0	0
North Fork Powder River	0	0	654	0	0
Upper Powder River	0	0	0	0	0
South Fork Powder River	0	0	0	0	0
Salt Creek	0	0	0	0	0
Crazy Woman Creek	0	0	0	0	443
Clear Creek	0	0	0	330	181
Middle Powder River	0	0	0	0	0
Little Powder River	0	0	0	0	0
Little Missouri River	0	0	0	0	0
Antelope Creek	0	0	0	0	0
Dry Fork Cheyenne River	0	0	0	0	0
Upper Cheyenne River	0	0	0	0	0
Lightning Creek	0	0	0	0	0
Upper Belle Fourche River	0	0	0	0	0
Middle North Casper River	0	0	0	0	0
Total	940	139	663	1,803	3,205

Table 3–45 Moose Ranges by Vegetation Type

	Moose Ranges (acres)				
Vegetation Type	Crucial Yearlong	Crucial Winter Yearlong	Winter Yearlong	Yearlong	Undetermined
Agriculture	0	120	670	499	0
Aspen	10	1	0	53	0
Coniferous Forest	843	1,371	2,800	10,976	1,792
Forested Riparian	41	965	798	947	1,628
Herbaceous Riparian	5	0	3	43	0
Mixed Grass Prairie	239	2,772	7,261	9,231	341
Other Shrublands	0	0	0	244	8
Sagebrush Shrublands	252	841	2,436	4,121	3,117
Shortgrass Prairie	0	47	111	222	33
Shrubby Riparian	8	3,151	3,666	6,128	0
Water	0	0	38	0	0
Wet Meadow	96	854	1,755	2,037	214

Raptors

Common raptor species expected to occur in suitable habitats within the Project Area include northern harrier (*Circus cyaneus*), golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*Buteo swainsoni*), ferruginous hawk (*Buteo regalis*), American kestrel (*Falco sparverius*), prairie falcon (*Falco mexicanus*), great horned owl (*Bubo virginianus*), short-eared owl (*Asio flammeus*), and burrowing owl (*Athene cunicularia*). The following sections briefly describe distribution, occurrence in Wyoming, ecology, and potential threats to raptor species that may occur within the Project Area.

Northern Harrier

This species occurs throughout much of North America with highest densities in the prairie pothole region of the U.S. and Canada (Kingery 1998). Harriers nest in a variety of habitats, including native and non-native grasslands, agricultural lands, and emergent wetland marshes and mountain sagebrush (Kingery 1998). In Wyoming, this species is a common summer resident feeding mostly on small mammals that it discovers while gliding (Luce et al. 1999). Possible threats may include direct disturbance or destruction of breeding habitats, habitats important to prey species, and indirect disturbance from construction, operation, or reclamation activities that may lead to nest failure or abandonment.

Bald Eagle

The bald eagle occurs throughout North America from Alaska to Newfoundland, and from southern Florida to southern California. In Wyoming, this bird is a breeding resident occurring in suitable habitats throughout the state. Breeding pairs utilize large, mature cottonwoods or conifer trees to hold their nests. These trees are often located near large streams, rivers, or lakes that support large populations of fish, an important prey base. Eagles also rely upon medium-sized

Figure 3–14 Moose Ranges

mammals (e.g., prairie dogs and jackrabbits), waterfowl, and wildlife and livestock carrion, depending upon the season and availability. Bald eagles nest throughout Wyoming and the Project Area. Nest location data for nests within the Project Area was provided by the WGFD Nongame Division. In the Project Area, active nests and winter roosts tend to be associated with forested riparian areas and large lakes and reservoirs that have mature cottonwood trees for nesting and roosting. Threats to this species include human disturbance, loss of suitable nesting and roosting trees, and prey scarcity due to anthropogenic effects.

Golden Eagle

In North America, this species occurs throughout the mountain and grassland regions where medium-sized mammals are available and abundant (Glinski 1998). Golden eagles typically nest on open cliffs or in trees. Important foraging habitats include grasslands, sagebrush, and farmlands (Kingery 1998). In Wyoming, this species is considered a common year-round resident feeding mostly on jackrabbits, rodents, small mammals, and carrion in the winter (Luce et al. 1999). Possible threats to this species may include disturbance of nesting areas leading to abandonment and disturbance or destruction of important habitats to prey species.

Red-tailed Hawk

Red-tailed hawks use a variety of habitats and range from Alaska south to Panama and east to Nova Scotia and the Virgin Islands (Kingery 1998). This species typically nest in patches of tall trees or on secluded cliff faces. In Wyoming, this species is considered year-round resident common to most habitats under 9,000 feet elevation including prairie grasslands, riparian areas, sagebrush communities, and pinyon/juniper woodlands (Luce et al. 1999). Typical prey include rodents and other small mammals. Possible threats to this species may include direct disturbance or destruction of breeding habitats, habitats important to prey species, and indirect disturbance from construction, operation, or reclamation activities that may lead to nest abandonment.

Swainson’s Hawk

The Swainson’s hawk is a New World hawk, breeding in North America and wintering in South America. This species will build their own nest in the tops of isolated trees or use nests built by magpies, crows, ravens, or other hawks (Kingery 1998). In Wyoming, this species is considered a summer resident common to grasslands and shrublands under 9,000 feet elevation (Luce et al. 1999). This species typically preys on rodents, small mammals, and occasionally rabbits. Concern for this species has increased following reports of significant habitat loss and exposure to pesticides on wintering grounds in South America. Swainson’s hawk are relatively sensitive to human disturbance near active nests. Possible threats to this species may include direct disturbance or destruction of breeding habitats, habitats important to prey species, and indirect disturbance from construction, operation, or reclamation activities that may lead to nest abandonment.

Rough-legged Hawk

The rough-legged hawk (*Buteo lagopus*) occurs from the northern latitudes of Canada during the summer months and in the United States from California east to Maine in the winter months. In Wyoming, this species occurs in the short- and mixed-grass prairies and sagebrush and other shrublands. Winter prey species include rodents, medium-sized mammals and upland birds. This species is considered a common winter resident in Wyoming (Luce et al. 1999). The primary threats in the Project Area are the loss of suitable prey and disturbance of suitable wintering and hunting habitats.

Ferruginous Hawk

The ferruginous hawk (*Buteo regalis*) occurs from southwestern Canada through the western U.S. and south into northern Mexico. This species breeds mainly in the northern part of its range and occupies the southern parts only in the winter. The heart of the most suitable nesting habitat is in the Dakotas (Glinski 1998). Nesting habitat is typically in shortgrass prairies where trees, similar constructed structures, cliffs, or even hilltops are used. Preferred foraging habitats include grasslands and shrublands (Kingery 1998). Ferruginous hawks typically feed on small to medium-sized mammals including jackrabbits, cottontails, ground squirrels, and prairie dogs (Kingery 1998). In Wyoming, this species is considered a common year-round resident (Luce et al. 1999). Possible threats include physical disturbance to suitable nesting habitats and habitats vital to populations of prey species.

American Kestrel

The American kestrel (*Falco sparverius*) is found throughout North and South America from Alaska south to the southernmost tip of South America. This species is known to breed in every state of the U.S., except Hawaii, and each province of Canada. American kestrels prefer open country with sufficient perches (e.g., dead trees, rock outcrops, utility poles and wires) for hunting insects and small mammals (Kingery 1998). Nesting sites often include tree cavities, crevices, cliffs, and nest boxes. In Wyoming, the kestrel is a common summer resident of suitable habitats below 8,500 feet elevation. Relatively tolerant of human activity, a possible threat to this species would be removal or destruction of suitable nesting substrates.

Prairie Falcon

The prairie falcon (*Falco mexicanus*) range over the western half of North America from southern Alberta, Saskatchewan, and British Columbia south to central Mexico (Kingery 1998). This species tends to nest on open cliff faces. Prairie falcons hunt birds and small mammals from perches and while soaring. In Wyoming, the prairie falcon is considered a common resident nesting in cliff habitats of open areas (Luce et al. 1999). Threats to this species may include displacement from traditionally nesting habitats due to human activity.

Great Horned Owl

The great horned owl (*Bubo virginianus*) occurs from the northern edge of the boreal forest in Alaska and Canada to the southern tip of South America. This owl typically nests in wooded areas adjacent to open spaces such as shrublands, grasslands, and farm fields that provide excellent opportunity for hunting rodents and other small mammals (Kingery 1998). In Wyoming, this owl is considered a common resident of most habitats under 9,000 feet elevation, especially cottonwood and riparian areas (Luce et al. 1999). Habitat loss is an important consideration in some areas of this species range, but in Wyoming human-caused mortalities is likely a more serious issue.

Short-eared Owl

The short-eared owl (*Asio flammeus*) occurs throughout Canada and central and northern United States. In Wyoming, this species is a common year-resident (Luce et al. 1999). This owl is a ground-nesting species, building its nest of grasses, weeds, and down feathers in short- and mixed-grass prairies and herbaceous wetlands (Kingery 1998). Threats to this species include the conversion or alternation of historically treeless prairies and increased predation by domestic dogs and cats, foxes, coyotes, and skunks due the expansion of human development.

Burrowing Owl

The burrowing owl (*Athene cunicularia*) occurs throughout the western United States, southwestern Canada, and northern Mexico. In Wyoming, this species is a breeding summer resident occurring throughout much of the state and (Luce et al. 1999). This species occupies rodent burrows and nests primarily in short- and mixed-grass prairies and shrublands. In many areas, this owl favors prairie dog colonies, that provide well-maintained burrows for nesting, mounds for perching, and low vegetation for unobstructed views of potential predators. Threats to rural populations include plague outbreaks, poisoning of rodent colonies, and elimination of nesting sites due to the conversion of prairie and shrublands to agricultural uses (Kingery 1998).

The Project Area is known to support suitable habitat for each of the raptor species listed (Luce et al. 1999). Although the presence of these raptor species has been documented in the Project Area, more specific data regarding their population size or patterns of occurrence were not available.

Upland Game Birds

Several species of upland game birds may occur within the Project Area, including ring-necked pheasant (*Phasianus colchicus*), gray partridge (*Perdix perdix*), blue grouse (*Dendragapus obscurus*), wild turkey (*Meleagris gallopavo*), mourning dove (*Zenaida macroura*), sage grouse (*Centrocercus urophasianus*) and sharp-tailed grouse (*Tympanuchus phasianellus*) (Luce et al. 1999). Specific concerns regarding the sage grouse and sharp-tailed grouse were identified during the scoping process. No other species were spcifically identified during the scoping process and therefore are not addresed further.

Sage Grouse

The sage grouse is a species of the sagebrush community in the plains and foothills of the arid west. This species occupies short- and mixed-grass prairies, sagebrush shrublands and other shrubland communities**,** wet meadows, and agricultural areas (Luce et al. 1999). Males of this species have an extravagant mating display that is performed on historical strutting areas termed “leks” (Terres 1980). In Wyoming, this species occurs as a breeding resident of habitats below 8,300 feet elevation throughout the state (Luce et al. 1999). Sage grouse leks occur throughout the Project Area. Direct disturbance of leks, nesting areas, and brood-rearing areas, and other human disturbance are the key threats to this species in the Project Area.

The 2001 Sage Grouse Job Completion Report, Sheridan Region, was referred to for information specific to the Project Area (Oedekoven 2001). The Sheridan Region of the WGFD approximates the Project Area. In the Sheridan Region, 269 lek locations are documented. Although distributed widely throughout the Project Area, most of these known leks occur in Campbell County on privately owned lands. Lek complexes are defined as one or more leks within approximately 0.5 to 2.0 miles of each other. Male sage grouse are known to breed on several different leks within a single breeding season. The WGFD rely upon lek complex data as the basis for analyzing sage grouse population trends. The number of active lek complexes has remained relatively stable for the past ten years, primarily because a single lek within a complex will characterize that complex as active. Average peak male attendance in 2001 was significantly lower than the previous year. Based on typical sex ratios of approximately one male for every two females, the trend in sage grouse populations in the Sheridan Region are experiencing a low period during a ten-year cycle of highs and lows. Overall, the sage grouse population appears to be steadily declining within the Project Area.

Plains Sharp-tailed Grouse

The sharp-tailed grouse occurs throughout much of central Canada and from Montana to central Nebraska. This species inhabits short- and mixed-grass prairie, sagebrush shrublands, woodland edges, and river canyons. In Wyoming, this species is restricted to mixed-grass prairie grasslands, sagebrush, shrublands, shrubby riparian areas and wet meadows of the eastern half of the state (Luce et al. 1999). Each spring, the males perform elaborate mating dances on historical dancing grounds called leks (Terres 1980). This species is a common breeding resident throughout Wyoming and is expected to occur in suitable habitats within the Project Area (Luce et al. 1999). Data provided by the WGFD, Nongame Division, indicate plains sharp-tailed grouse leks occur primarily in the northwestern portion of the Project Area. Physical disturbance of nesting and brood-rearing habitats and human disturbance at or near leks are primary threats to this species within the Project Area.

Waterfowl

Suitable waterfowl habitats within the Project Area include major rivers, streams, creeks, draws, lakes, and ponds. Waterfowl species that can be expected to occur in the area include Canada goose (*Branta canadensis*), wood duck (*Aix sponsa*), mallard (*Anas platyrhynchos*), gadwall (*Anas strepera*), green-winged teal (*Anas crecca*), American wigeon (*Anas americana*), northern pintail (*Anas acuta*), northern shoveler (*Anas clypeata*), blue-winged teal (*Anas discors*), cinnamon teal (*Anas cyanoptera*), canvasback (*Aythya valisineria*), and redhead (*Aythya americana*) (National Geographic 1999).

The occurrence and distribution of these species is variable and influenced by local conditions such as aquatic habitat, adjacent upland habitat, season, and land use practices. These waterfowl species are expected to occur in suitable habitats within the Project Area during the appropriate species-specific nesting, migration, and wintering seasons.

Aquatic Species

Of the 18 sub-watersheds identified within the Project Area, ten would receive produced water from CBM wells. These ten sub-watersheds are included in the five major watersheds within the project area. The five major watersheds and their corresponding sub-watersheds are:

- Powder River Basin, including five sub-watersheds: Upper Powder River Basin, Salt Creek Basin, Crazy Woman Creek Basin, Clear Creek Basin, and the Middle Powder River Basin;
- Little Powder River Basin;
- Upper Tongue River Basin;
- Upper Belle Fourche River Basin;
- Upper Cheyenne River Basin including two sub-watersheds: Antelope Creek Basin and Upper Cheyenne River Basin.

Additional details about the sub-watersheds are presented in the discussion of surface water, which begins on page 3–14.

Specific habitat data for many of the streams and rivers within the Project Area were not available; however, general existing conditions for the five major watersheds were available (Wiley 2001a). Lack of accurate data for fish populations, patterns of occurrence, and habitats in all, or portions of, these drainages limits information on fish distribution, particularly native non-game fish, within the Project Area. Descriptions of the existing conditions for the Powder River Basin, Little Powder River Basin, Tongue River Basin, Belle Fourche River Basin, and Cheyenne River Basin follow.

Powder River Basin

The Powder River is a rare example of a free-flowing prairie stream. No dams exist over its entire length. Including tributaries, the drainage encompasses approximately 8,000 square miles. The South Fork Powder, Salt Creek, Clear Creek, and Crazy Woman Creek are major tributaries. Virtually all of the bottomland and riparian areas of the PRB are privately owned. Public lands, usually sagebrush or grasslands in uplands adjacent to the river, are managed by the BLM and are concentrated in the PRB about mid-way down the Powder River and in the upper reach of the South Fork Powder River (Bradshaw 1996).

Historically, the PRB was used extensively and almost exclusively for cattle and sheep grazing. Oil and gas developments and recently developed coal mines have become dominant land uses over the past 80 years (Bradshaw 1996).

Perennial streams in the PRB include the South Fork Powder River, Salt Creek, Crazy Woman Creek, and Clear Creek. Another 52 intermittent or ephemeral tributaries to the Powder River also exist. Although species presence or abundance data are lacking for most of these seasonal tributaries, none support game fish and most are believed to hold no fish at all. Two of the native fish species that do occur, goldeye and sturgeon chub, are considered rare by the WGFD (Bradshaw 1996).

Native stream-dwelling gamefish are channel catfish, sauger, shovelnose sturgeon, and stonecat. Channel catfish, sauger, and shovelnose sturgeon occur most commonly below the mouth of Crazy Woman Creek as seasonal migrants from the Yellowstone River or the Powder River in Montana. Trout are found in the headwaters of South Fork Powder River, Willow Creek and Sanchez Creek (Bradshaw 1996).

The Powder River supports a diverse fish fauna of mostly native, nongame species, but specific life history information is lacking for most main stem Powder River fishes. Sturgeon chub, once endemic to several Wyoming rivers, but now found only in the Powder River, are considered rare by the WGFD. This species is not only adapted to turbidity, but apparently requires it because they are not found above the confluence of Salt Creek and the Powder River where turbidity is reduced. This spring spawner is found over swift rocky riffles throughout the Powder River (Bradshaw 1996).

Prior to 1978, the shovelnose sturgeon was considered rare; however, more recently it has been recognized as a fairly common seasonal migrant from the Yellowstone River in Montana. When they are present in the Powder River during the spring a small, but unknown, number of fish are taken by anglers. Shovelnose sturgeon are known to use Clear Creek and Crazy Woman Creek for spawning but, because of sampling difficulties, it is unknown if they use the Powder River for spawning or how far they ascend the river (Bradshaw 1996).

Basin geology is responsible for the river's reputation as a turbid, muddy stream. The Powder River has a typical snowmelt hydrograph driven by accumulations in the southern Bighorn Mountains. Peak flows occur from April through June and low flows occur from November through February. Flow variation is naturally high and is exacerbated by irrigation withdrawals throughout the drainage. Repeated withdrawal and return of irrigation water undoubtedly contributes to high summer temperatures that reach 85 to 90°F. Such high water temperatures are lethal to salmonids and may influence aquatic invertebrate diversity that has been characterized as low (Bradshaw 1996).

Though occasionally the river clears, it is typically very turbid during spring runoff and after storms. The river is generally shallow and contains portions of shifting streambed composed of fine sands and clays that provide minimal aquatic invertebrate habitat. Low light penetration through the turbid water also contributes to low aquatic invertebrate production by inhibiting vegetation growth (Bradshaw 1996).

Salt Creek is a major tributary of the Powder River and, during low flow periods, contributes the majority of the flow to the Powder River. Streamflows in Salt Creek are augmented by water discharged from oil and gas wells drilled in the Salt Creek Field near Midwest, Wyoming. This water contains elevated levels of

TDS, chlorides, sulfates, and sodium. Depending on the time of year, these constituents can be diluted fairly quickly after Salt Creek joins the Powder River, or may remain at elevated levels during low flow periods. Although fish in Salt Creek apparently do not suffer from elevated chemical constituents or the small amounts of oil found in the water, toxicity for zooplankton (*Cereodaphnia* spp.) and fathead minnows has been documented (Bradshaw 1996).

Extreme fluctuation in streamflow and temperature, low aquatic invertebrate production, high turbidity, and dissolved solids, and an unstable streambed limit the population visibility of salmonids and most Wyoming gamefish. Consequently, sportfish management options are limited. Similar conditions prevail in the tributaries of the Powder River (Bradshaw 1996).

Little Powder River Basin

The fish assemblage in the Little Powder River basin in northeast Wyoming is limited due to a lack of habitat and low flow. The northern three-fourths of the Little Powder River Basin is sagebrush steppe and ponderosa forest, whereas the southern one-fourth is mixed-grass prairie. Land use in the basin is primarily livestock grazing with hay production in the valleys and riparian areas (Stewart 1996).

The Little Powder River drainage covers 1,836 square miles. Roughly 10 percent of the drainage is public land, including National Grasslands, BLM, and State of Wyoming lands. Elevation in the drainage ranges from 3,340 feet at the Wyoming-Montana border to 4,900 feet on the Belle Fourche-Little Powder hydrographic divide near Gillette (Stewart 1996).

Flowing water in this drainage is restricted to three stream reaches, all of which are on private land. The Little Powder River and a short reach of the Dry Fork of the Little Powder River below its confluence with Moyer Springs Creek have perennial water. The only coldwater habitat in the drainage is Moyer Springs Creek, a 0.5 mile reach of stream that contains a wild brook trout population with flows usually less than one cfs. There is no perennial water in any of the other tributary streams in the drainage. There is only one small standing water lake, Weston Reservoir (Little Powder Reservoir), that is suitable for gamefish and on accessible public land (Stewart 1996).

Habitats for fish are very limited in this drainage due to the low mean annual water balance and overall small size of the ephemeral streams. During extreme low water periods, habitat may be restricted to large pools that become isolated when streamflows cease. Many standing waters do not consistently support fish populations due to drying or low water levels during drought periods. The low water levels contribute to winterkill or summer die-offs. Channel catfish populations exist in the lower Little Powder River, but because of the stream’s small size the potential for a sport fishery is very low. There are several limiting factors in the Little Powder River Basin. Lack of water limits fish habitats and low-water conditions in standing waters and lack of perennial flow in most of the drainage limits sport fishery potential and indigenous fishes in the basin (Stewart 1996).

Upper Tongue River Basin

The Upper Tongue River drainage in northcentral Wyoming has a diverse fish assemblage. Streams in the headwaters contain Snake River cutthroat trout, rainbow, brown, and brook trout, whereas a reach of the lower river contains sauger and smallmouth bass. The headwaters of the Tongue River drainage originate on the east side of the hydrographic divide of the Bighorn National Forest. After the North and South Tongue Rivers join to form the main stem Tongue River, the flow is primarily east and north until the Tongue River flows into Montana. Standing waters in this basin are primarily privately owned ponds, many of which are unsuitable for supporting fish populations. Elevations in the Tongue River drainage vary from 3,470 feet to10,046 feet (Wiley 2001a).

The North and South Tongue watersheds are predominantly conifer and alpine meadows with extensive willow complexes in some riparian areas. Logging, livestock grazing, and road building have accelerated the natural erosion process that contributes silt to the system. The Tongue River flows through a canyon for several miles before exiting onto the plains near the Bighorn National Forest boundary at the town of Dayton. From Dayton to the state line, it flows through an alluvial floodplain. Land use on this floodplain is predominantly agriculture, but residential development and one coal mine also exist (Wiley 2001a).

The South Tongue and North Tongue watersheds are conducive to natural trout reproduction. Below the canyon, suitable mountain whitefish reproductive habitat exists, and the Lower Tongue River supports suitable spawning habitat for sauger, smallmouth bass, stonecats, rockbass and other native and non-native nongame species (Wiley 2001a). Although some of these streams support suitable trout spawning habitat, much of this drainage supports native and non-native game fish.

The absence or scarcity of deep pools in several of the headwater tributary streams limits the habitat diversity and potential for larger fish populations. Sedimentation limits natural fish and macroinvertebrate production in many streams, especially the upper North Tongue watershed. Irrigation diversions reduce flows on many streams, and these reduced flows usually occur during critical life stages of fish and macroinvertebrates. From Interstate 90 downstream to the border, irrigation diversions form barriers that impede seasonal upstream movements of channel catfish, sauger, and smallmouth bass, as well as certain nongame species. Fish, especially channel catfish, move downstream in the fall and winter into Tongue River Reservoir in Montana, and the barriers impede upstream movement during spring (Wiley 2001a).

Upper Belle Fourche River Basin

The Upper Belle Fourche River drainage has over 3,762 square miles in the basin. Elevations in the drainage range from 3,100 feet in the northeast corner of Crook County at the Wyoming-South Dakota state line to 6,645 feet at Warren Peak. The topography is mostly rolling grasslands and sagebrush, with the exception of the ponderosa pine-dominated forest in the Black Hills National Forest. The principal use of the drainage is for livestock grazing and hay production. Water diversions for irrigation are common. Other uses common in the drainage include oil and gas production, timbering, mining for coal and bentonite, and recreation (Wiley 2001a).

Most of the streams are unsuitable for coldwater fish and offer limited potential for warmwater game fish, due to water diversion and lack of suitable habitat. Beaver ponds on some minimal flow streams provide localized trout habitat and many of the small streams in the Black Hills depend on beaver ponds to provide habitat for fish; however, flash flood events or heavy sedimentation periodically eliminate these ponds for fisheries. There are only four streams in the drainage that contain self-sustaining trout populations including Sand Creek, Spottedtail Creek, Cold Springs Creek, and Ogden Creek. The majority of the game fish potential exists in the numerous farm ponds and reservoirs, but many of these are subject to periodic winter or summer kills due to limited water availability. Many of the farm ponds and privately owned reservoirs contain stunted populations of bullhead or green sunfish. The largest lentic fishery in the drainage is Keyhole Reservoir (Wiley 2001a).

Suitable habitats for game fish are minimal in the Upper Belle Fourche River drainage, due to the small size and low flow of the Upper Belle Fourche River and its tributaries. Small reservoir impoundments are abundant in this drainage, and game fish habitats are restricted to small impoundments and to a relatively few stream segments. Fish habitats in many streams are mainly confined to pools that may be isolated during extreme low water conditions. Lentic water habitats are limited by drought periods, drawdowns for irrigation, and stock watering. Shallow depths of lentic habitat often limits overwintering for fish, periodically resulting in partial or complete winterkills (Wiley 2001a).

Existing limiting factors for the Upper Belle Fourche River Basin include low oxygen and high temperatures during periods of low flow, cattle grazing impacts (i.e., nutrient enrichment, and compacting and devegetation of upland and riparian areas leading to increased erosion and siltation), and exotic species invasion (Wiley 2001a).

Upper Cheyenne River Basin

The Upper Cheyenne River qualifies as one of Wyoming's free-flowing prairie streams because it is not dammed until it reaches Angostura Reservoir in South Dakota. The surface area of the basin is approximately 5,160 square miles. The basin contains the southern end of the Black Hills, the breaks of the Rochelle Hills south of Gillette, and the rolling hills and grasslands north of Lusk. Elevations range from 3,500 feet where the river enters South Dakota to 6,000 feet in the sand hills of Converse County. Sagebrush and grasslands are the predominant vegetation types in the basin, with ponderosa pine in the Black Hills and Rochelle Hills (Wiley 2001a).

Virtually all of the bottomland and riparian areas of the Cheyenne River are privately owned; however, about 45 percent of the basin is public land managed by the BLM, FS, and State Land and Farm Loan Office. Major land uses include oil and gas development, bentonite mining, and livestock grazing and associated irrigation diversions, reservoirs, and stock ponds (Wiley 2001a).

The Lower Cheyenne River becomes intermittent in most years. Because the Cheyenne River and major tributaries are intermittent most years, the drainage has been considered unsuitable for game fish, but Patton (1996) confirmed the presence of green sunfish and black bullhead in Beaver Creek. Within the Upper Cheyenne River drainage, there are 56 other tributaries considered by the WGFD as unsuitable to support game fish (Wiley 2001a).

The Upper Cheyenne River hydrograph is driven by low elevation snow accumulations, seasonal rainfall, and periodic storm events. Near the South Dakota state line, flows cease during most years. The repeated withdrawal, warming, and return of irrigation water undoubtedly contributes to high summer temperatures that reach 70 to 80ºF during summer. The Cheyenne River and many of its tributaries flow through erodable shales, claystones, sandstones, and bentonite deposits. This underlying geology causes most basin streams to be generally turbid, particularly during runoff or after storm events. Turbidity prevents light penetration needed for growing aquatic vegetation, channel instability, and high temperatures probably inhibiting aquatic macroinvertebrate production and creating an environment hostile to fish species not adapted to such conditions (e.g., game fish) (Wiley 2001a).

Existing limiting factors for the Upper Cheyenne River Basin, such as extreme fluctuation in streamflow and temperature, low aquatic invertebrate production, and high turbidity, limit the ability of most streams to support game fish, particularly cold- and cool-water species. Little is known of the habitat requirements, relative abundance, or spatial distribution of indigenous fish in the Upper Cheyenne River Basin. There is presently no baseline against which to measure indigenous fish population trends. There have been repeated illegal introductions of green sunfish and black bullhead into waters where they become overabundant, precluding game species and native non-game species from some areas (Wiley 2001a).

Within the Project Area, major rivers, creeks, draws, lakes, and ponds support a variety of fish species. Table 3–46 shows the occurrence of fish species by watershed. The WDFG assigns status categories to native aquatic species (Wiley 2001b). These rankings are also listed in Table 3–46.

Table 3–47 lists preferred habitats for fish species identified to occur within the Project Area. Some species occur only in streams and rivers, others occur only in lakes and ponds, while others occur in all four habitat types. Table 3–47 indicates the preferred habitats only and all species could be found within any of the four habitats.

Threatened, Endangered, or Sensitive Species

Regional Characterization

This section briefly discusses the biology of species that have been afforded special status by federal and state agencies including USFWS, FS, BLM, and WGFD. The special status designations include:

Table 3–46 Occurrence of Fish Species by Sub-watershed

Fish Species: Common Name (scientific name)	Wyoming Native Species Status[3]	Little Bighorn River[2]	Upper Tongue River[1,2]	Middle Fork Powder River[1,2]	North Fork Powder River[1]	Upper Powder River[1,2]	South Fork owder River[1]	Salt Creek[1]	Crazy Woman Creek[1]	Clear Creek[1]	Middle Powder River[1]	Little Powder River[1]	Little Missouri River[1,2]	Antelope Creek[1]	Dry Fork Chey-enne River[1]	Upper Cheyenne River[1,2]	Lightning Creek[1]	Upper Belle Fourche River[1,2]	Middle North Platte Casper[2]
Black bullhead (*Ameirus melas*)(N)	NSS3		X										X	X	X	X	X	X	X
Black crappie (*Pomoxis nigromaculatus*)(I)						X													X
Bigmouth shiner (*Notropis dorsalis*)(N)	NSS4																		X
Brassy minnow (*Hybognathus hankinsoni*)(N)	NSS6					X				X	X		X						X
Brook trout (*Salvelinus fontinalis*)(I)		X	X	X									X			X		X	
Brown trout (*Salmo trutta*)(I)		X	X	X		X										X		X	X
Channel catfish (*Ictalurus punctatus*)(N)	NSS4		X			X			X		X		X			X		X	X
Common carp (*Cyprinus carpio*)(I)			X			X			X	X	X	X	X	X	X	X	X	X	X
Common shiner (*Luxilus cornutus*)(N)	NSS3																		X
Creek chub (*Semotilus atromaculatus*)(N)	NSS5		X			X	X			X	X							X	X
Emerald shiner (*Notropis lutrensis*)(I)						X													X
Fathead minnow (*Pimephales promelas*)(N)	NSS6	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Finescale dace (*Phoxinus neogaeus*)(N)	NSS1																	X	
Flathead chub (*Platygobio gracilis*)(N)	NSS3	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Gizzard shad (*Dorosoma cepedianum*)(N)																X			X
Golden shiner (*Notemigonus crysoleucas*)(I)																			X
Goldeye (*Wiodon alosodies*)(N)	NSS2					X			X	X	X	X	X						
Green sunfish (*Lepomis cyanellus*)(I)			X									X	X	X	X	X	X	X	X
Iowa darter (*Etheostoma exile*)(N)	NSS4																		X

Table 3–46 Occurrence of Fish Species by Sub-watershed

Fish Species: Common Name (scientific name)	Wyoming Native Species Status[3]	Little Bighorn River[2]	Upper Tongue River[1,2]	Middle Fork Powder River[1,2]	North Fork Powder River[1]	Upper Powder River[1,2]	South Fork owder River[1]	Salt Creek[1]	Crazy Woman Creek[1]	Clear Creek[1]	Middle Powder River[1]	Little Powder River[1]	Little Missouri River[1,2]	Antelope Creek[1]	Dry Fork Cheyenne River[1]	Upper Cheyenne River[1,2]	Lightning Creek[1]	Upper Belle Fourche River[1,2]	Middle North Platte Casper[2]
Johnny darter (*Etheosoma nigrum*)(N)	NSS7																		X
Lake chub (*Couesius plumbeus*)(N)	NSS3		X										X					X	X
Lake trout (*Salvelinus namaycush*)(I)						X													
Largemouth bass (*Micropterus salmoides*)(I)		X											X			X		X	
Longnose dace (*Rhinichthys cataractae*)(N)	NSS7	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	
Longnose sucker (*Catostomus catostomus*)(N)	NSS4		X	X	X	X			X	X	X	X							X
Mosquitofish (*Gambusia affinis*)(I)																X	X		
Mountain sucker (*Catostomus platyrhynchus*)(N)	NSS3	X	X	X	X	X	X		X		X							X	
Mountain whitefish (*Prosopium williamsoni*)(N)	NSS4	X	X																
Northern redhorse (*Maxostoma macrolepidotum*)(N)	NSS4		X			X			X	X	X	X	X					X	X
Plains killifish (*Fundulus zebrinus*)(N)	NSS6					X	X				X			X	X	X	X		
Plains minnow (*Hybognathus placitus*)(N)	NSS3		X			X	X	X		X	X	X		X	X	X	X	X	
Quillback (*Carpiodes cyprinus*)(N)	NSS4																	X	X
Rainbow trout (*Oncorhynchus mykiss*)(I)		X	X			X							X			X		X	X
Red shiner (*Cyprinella lutrensis*)(N)	NSS7																	X	X
River carpsucker (*Carpiodes carpio*)(N)	NSS4					X			X	X	X			X	X	X	X	X	X
Rock bass (*Ambloplites rupestris*)(I)			X			X				X	X								
Sand shiner (*Notropis stramineus*)(N)	NSS7		X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sauger (*Stizostedion canadense*)(N)	NSS2		X																

Table 3–46 Occurrence of Fish Species by Sub-watershed

Fish Species: Common Name (scientific name)	Wyoming Native Species Status[3]	Sub-watershed: Little Bighorn River[2]	Upper Tongue River[1,2]	Middle Fork Powder River[1,2]	North Fork Powder River[1]	Upper Powder River[1,2]	South Fork owder River[1]	Salt Creek[1]	Crazy Woman Creek[1]	Clear Creek[1]	Middle Powder River[1]	Little Powder River[1]	Little Missouri River[1,2]	Antelope Creek[1]	Dry Fork Cheyenne River[1]	Upper Cheyenne River[1,2]	Lightning Creek[1]	Upper Belle Fourche River[1,2]	Middle North Platte Casper[2]
Silvery minnow (*Hybognathus nuchalis*)(N)	NSS1											X	X						
Smallmouth bass (*Micropterus dolomieui*)(I)		X			X				X	X		X			X		X		
Snake River cutthroat trout (*Oncorhynchus clarki ssp.*)(N)	NSS4	X													X		X		
Spottail shiner (*Notropis hudsonius*)(I)																		X	
Stonecat (*Notorus flavus*)(N)	NSS4	X		X	X			X	X	X	X	X					X	X	
Stoneroller (*Campostoma anomalum*)(N)	NSS4																	X	
Sturgeon chub (*Macrhybopsis gelida*)(N)	NSS1				X			X		X									
Walleye (*Stizostedion vitreum*)(I)		X			X										X		X	X	
White crappie (*Pomoxis annularis*)(I)		X																X	
White sucker (*Catostomus commersoni*)(N)	NSS7	X		X	X		X	X	X	X	X				X	X	X	X	
Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*)(N)	NSS2	X																	
Yellow perch (*Perca flavescens*)(I)		X	X														X	X	

Notes:
1. Data from Patton, 1997.
2. Data from Wyoming Game and Fish Basin Management Plans (Wiley 2001a). (I) = Introduced species in Wyoming. (N) = Native species in Wyoming.
3. Status 1 Species – Populations are physically isolated and/or exist at extremely low densities throughout range. Habitats are declining or vulnerable. Extirpation appears possible. The Wyoming Game and Fish Commision mitigation category is "Vital". The mitigation objective for this resource category is to realize "no loss of habitat function". Under these guidelines, it will be very important that the project be conducted in a manner that avoids alteration of habitat function. Status 2 Species - Populations are physically isolated and/or exist at extremely low densities throughout range. Habitat conditions appear stable. The Wyoming Game and Fish Commision mitigation category is "Vital". Status 3 Species – Populations are widely distributed throughout its native range and appear stable. However, habitats are declining or vulnerable. The Wyoming Game and Fish Commision mitigation category is "High". The mitigation objective for this category is to realize "no net loss of habitat function within the biological community which encompasses the project site". Under these guidelines, it will be important that the project be conducted in a manner that avoids the impact, enhances similar habitats, or results in the creation of an equal amount of similarly valued fishery habitat. Status 4-7 Species – Populations are widely distributed throughout native range and are stable or expanding. Habitats are also stable. There is no special concern for these species.

Table 3–47 Preferred Habitats of Fish Species

Common Name	Habitat Types[1] Streams and Rivers (Lotic)	Ponds and Lakes (Lentic)	All Habitats (Lotic and Lentic)	Specific Preferred Habitats
Black bullhead			X	prefers small muddy lakes; found in pools in large and small streams
Black crappie		X		
Bigmouth shiner			X	prefers sandy streams; sometimes in lakes
Brassy minnow			X	weedy streams, clear creeks with sand and gravel bottoms; occasionally in lakes
Brook trout			X	prefers small, cold streams and beaver ponds; mountain lakes; plains lakes occasionally
Brown trout	X			prefers larger foothill streams with slower-moving waters; rarely does well in lakes
Channel catfish			X	prefers large clear rivers; tolerates turbid water; game fish in lakes
Common carp			X	lakes; pools and backwaters in rivers
Common shiner	X			prefers clear, gravel-bottomed streams
Creek chub	X			prefers clear, gravel-bottomed creeks
Emerald shiner	X			
Fathead minnow			X	prefers smaller streams, many ponds, and some lakes
Finescale dace			X	prefers cool, weedy, small streams, ponds, and small lakes
Flathead chub	X			prefers large silty rivers
Gizzard shad			X	prefers larger streams and reservoirs
Golden shiner			X	prefers standing or slowly moving water with abundant vegetation
Goldeye			X	prefers lakes and streams, adapted for turbidity
Green sunfish			X	prefers pools in small to medium-sized streams, small lakes, ponds, and sloughs
Iowa darter			X	prefers clear, cool, weedy streams, lake shorelines
Johnny darter	X			prefers small, stream-red, high gradient streams
Lake chub			X	prefers cool foothill streams and sometimes lakes
Lake trout		X		prefers cold, deep lakes
Largemouth bass			X	prefers lakes and backwaters of streams
Longnose dace	X			prefers riffles in small and large streams
Longnose sucker			X	prefers cold water lakes, streams and rivers
Mosquitofish			X	prefers streams and lakes
Mountain sucker			X	prefers larger creeks and rivers, alpine lakes

Table 3–47 Preferred Habitats of Fish Species

Common Name	Habitat Types[1] Streams and Rivers (Lotic)	Ponds and Lakes (Lentic)	All Habitats (Lotic and Lentic)	Specific Preferred Habitats
Mountain whitefish	X			prefers large, cold, clear rivers
Northern redhorse			X	prefers medium-sized streams and small lakes
Plains killifish	X			prefers shallow sandy streams
Plains minnow	X			prefers slower water and side pools in silty streams
Quillback	X			
Rainbow trout			X	
Red shiner	X			prefers medium-sized streams in medium current
River carpsucker	X			prefers clear and turbid rivers and streams
Rock bass	X			prefers pools in streams
Sand shiner	X			prefers permanent sandy streams
Sauger			X	prefers large rivers and reservoirs
Silvery minnow	X			prefers larger rivers
Smallmouth bass			X	prefers cool, clear rivers and large, cool, clear lakes
Snake River cutthroat trout	X			prefers swift streams
Spottail shiner			X	prefers large rivers and lakes
Stonecat	X			prefers rubble-bottomed streams
Stoneroller	X			prefers small streams tributary to North and South Platte Rivers
Sturgeon chub	X			prefers large, silty rivers
Walleye			X	prefers lakes and rivers
White crappie		X		
White sucker			X	prefers lakes and streams, avoid current
Yellowstone cutthroat trout	X			
Yellow perch		X		

Sources: Baxter and Simon 1970, Woodling 1985

- Species listed as threatened or endangered, proposed for listing as threatened or endangered, or considered as a candidate for listing as threatened or endangered by the USFWS,
- Species listed as sensitive by the BLM or FS, and
- Species categorized by WGFD as SSC1-6. WGFD recognizes six classes of special concern, of which classes 1, 2, and 3 are considered to be high priorities for conservation.

The USFWS is directed by the ESA to identify and protect threatened and endangered plant and animal species. The ESA identifies the following categories to rank listed and candidate species.

The term "endangered species" means any species that is in danger of extinction throughout all or a significant portion of its range [(ESA §3(6)]. In addition to determining that a species will be listed as endangered, the USFWS may also designate critical habitat for a species as defined in section 3(5) of the ESA [ESA §4(b)(6)(C)].

Except as provided in sections 6(g)(2) and 10 of the ESA, with respect to any endangered species of fish or wildlife listed pursuant to section 4 of the ESA it is unlawful for any person subject to the jurisdiction of the United States to import, export, take, possess, deliver, receive, carry, transport, ship, or sell or offer for sale any such species, or violate any regulation pertaining to such species [ESA §9(a)(1)(A-G)]. The term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct [ESA §3(18)].

Except as provided in sections 6(g)(2) and 10 of the ESA, with respect to any endangered species of plant listed pursuant to section 4 of the ESA it is unlawful for any person subject to the jurisdiction of the United States to import, export, remove and reduce to possession, maliciously damage or destroy, remove, cut, dig up, deliver, receive, carry, transport, ship, or sell or offer for sale any such species, or violate any regulation pertaining to such species [ESA §9(a)(2)(A-E)].

The term "threatened species" means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range [ESA §3(19)]. In addition to determining that a species will be listed as threatened, the USFWS may also designate critical habitat for a species as defined in section 3(5) of the ESA [ESA §4(b)(6)(C)].

Whenever a species is listed as threatened pursuant to section 4(c) of the ESA, the USFWS shall issue such regulations as deemed necessary and advisable to provide for the conservation of such species. The USFWS may by regulation prohibit any act prohibited under section 9(a)(1) for fish and wildlife species, or section 9(a)(2) for plant species with respect to endangered species [ESA §4(d)]. In general, equivalent protections are given for threatened species as are given for endangered species, based on the USFWS' implementing regulations for threatened species (50 CFR 17.31).

Proposed species are those species for which the USFWS has published a proposed rule for listing under the provisions of section 4(b)(5) of the ESA. The USFWS has 12 months to act on such a proposal, although this period may be extended in cases where additional information is needed to complete the listing package, or where other priorities cause the postponement of completion of the listing package.

Candidate species are those species for which the USFWS has sufficient information on biological vulnerability and threats to warrant issuance of a proposed rule for listing, but for which publication of a proposed rule for listing is precluded by other higher priority listing actions ("warranted but precluded"). The candidate list also includes all species for which a petition finding of warranted but precluded has been issued. For example, a petition was submitted to the USFWS requesting that the black-tailed prairie dog be listed as threatened. The USFWS has ruled that it has sufficient information to list the blacck-tailed prairie dog, but that other listing priorities preclude the issuance of a proposal to list the black-tailed prairie dog. The candidate list is reviewed on an annual basis, most recently in findings issued on October 30, 2001.

Candidate species are not afforded any federal statutory protections until such a time as a proposed rule for listing is published. Nevertheless, candidate species are often considered during project development in order to avoid the need for additional consultation and the potential for project delays in the event that a species is proposed for listing, or listed, prior to project completion.

The National Forest Management Act includes provisions which state that the maintenance of biodiversity must be considered in managing National Forest lands. Forest Service Manual 2670.22 requires the FS to maintain viable populations of all native and desired non-native wildlife, fish, and plants in habitats distributed throughout their geographic range on National Forest System lands. In recognition of the need to specially manage rare plants and animals on the lands that it administers, the FS designates certain species as sensitive. Specific management requirements and standards are often implemented for sensitive species in individual Forest Plans. The FS sensitive species are provided protection only in situations where the agency has some control over activities.

The FLPMA requires that the BLM manage the public lands in a manner that will protect the quality of scientific, ecological, and environmental values (including native plants and animals) and that will protect certain public lands in their natural condition.

BLM Manual 6840 states that it is BLM policy to carry out management consistent with the principles of multiple use for the conservation of candidate plant and animal species and their habitats and to ensure that actions authorized, funded, or carried out do not contribute to the need to list any of these species as threatened or endangered.

The BLM has developed a sensitive species policy and list for public lands in Wyoming. Under this policy, State Directors may designate sensitive species, usually in cooperation with the State wildlife agency. By definition, the sensitive species designation includes species that could easily become endangered or extinct in the state. Therefore, if sensitive species are designated by the State Director then the protection provided by the policy for candidate species shall be used as the minimum level of protection.

The WGFD has developed a matrix of habitat and population variables to determine the conservation priority of all native, breeding bird, and mammal species in the state. Six classes of Species of Special Concern (SSC) are recognized, of which classes 1, 2, and 3 are considered to be high priorities for conservation attention. These three highest priority designations are defined here.

SSC1: Includes species with ongoing significant loss of habitat and with populations that are greatly restricted or declining (extirpation appears possible).

SSC2: Species in which (1) habitat is restricted or vulnerable (but no recent or significant loss has occurred) and populations are greatly restricted or declining; or (2) species with on-going significant loss of habitat and populations that are declining or restricted in numbers and distribution (but extirpation is not imminent).

SSC3: Species in which (1) habitat is not restricted, but populations are greatly restricted or declining (extirpation appears possible); or (2) habitat is restricted or vulnerable (but no recent or significant loss has occurred) and populations are declining or restricted in numbers or distribution (but extirpation is not imminent); or (3) significant habitat loss is on-going but the species is widely distributed and population trends are thought to be stable.

SSC4: Species in which (1) populations are declining or restricted in numbers and/or distribution but extirpation is not imminent; and/or habitat is not restricted or vulnerable (but no recent or significant loss has occurred) and species is not sensitive to human disturbance; or (2) species is widely distributed, population status or trends are unknown but are suspected to be stable; habitat is restricted or vulnerable but no recent or on-going significant loss; species may be sensitive to human disturbance.

Much of the information available for the following special status species is restricted to public lands, including lands administered by BLM, FS, and USFWS. Unfortunately, similar information is generally not available for privately owned lands. Therefore, the occurrence of the following special status species is unverified for much of the privately owned lands within the Project Area. Although unverified, sensitive species will be assumed to occur in all suitable habitats within the Project Area, despite land ownership, for the purpose of this assessment.

Special-Status Plant Species

U.S. Fish and Wildlife Service

Ute ladies'-tresses Orchid

Ute ladies'-tresses orchid (*Spiranthes diluvialis*), listed as a federally threatened species, is a perennial herb with erect, glandular-pubescent stems 12 to 50 centimeters tall arising from tuberous-thickened roots (USFWS 1992). This species flowers from late July to September. Plants probably do not flower every year and may remain dormant below ground during drought years. It is currently known from western Nebraska, southeastern Wyoming, north-central Colorado, northeastern and southern Utah, east-central Idaho, southwestern Montana, and central Washington. In Wyoming, Ute ladies'-tresses orchid is known from the western Great Plains in Converse, Goshen, Laramie, and Niobrara counties. Rangewide, Ute ladies'-tresses orchid occurs primarily on moist, subirrigated or seasonally flooded soils in valley bottoms, gravel bars, old oxbows, or floodplains bordering springs, lakes, rivers, or perennial streams at elevations between 1,780 and 6,800 feet elevation (Fertig and Beauvais 1999). Suitable soils vary from sandy or coarse cobbley alluvium to calcareous, histic, or fine-textured clays and loams. Populations have been documented from alkaline sedge meadows, riverine floodplains, flooded alkaline meadows adjacent to ponderosa pine, Douglas fir woodlands, sagebrush steppe, and streamside floodplains. Some occurrences are also found on agricultural lands managed for winter or early season grazing or hay production. Known sites often have low vegetative cover and may be subjected to periodic disturbances such as flooding or grazing. Populations are often dynamic and "move" within a watershed as disturbances create new habitat or succession eliminates old habitat (Fertig and Beauvais 1999).

This species is known from four occurrences in Wyoming, all discovered between 1993-1997 (Fertig and Beauvais 1999). One of these occurrences is recorded from northwestern Converse County and is included within the Project Area. This species is expected to occur in suitable habitats within the Project Area.

Wyoming BLM and Forest Service

Some of the following species that follow are not expected to occur within the Project Area. They are included because these species are on the BLM and FS candidate and sensitive species lists and occur near the Project Area.

Laramie Columbine

Laramie columbine (*Aquilegia laramiensis*) is listed as a sensitive species by Wyoming BLM and Region 2 FS. This species is a perennial, leafy, many-stemmed herb 10 to 20 centimeters tall. This species flowers and fruits from June to August. The Laramie columbine is endemic to the Laramie Range of southeast Wyoming (Albany and Converse counties). It is often found in shady crevices of north-facing granite boulders and cliffs with pockets of rich soil between 6,250 and 8,000 feet elevation (Fertig and Beauvais 1999).

Laramie columbine is known from the eight extant populations all restricted to extreme southern Converse county and northern Albany county (Fertig and Beauvais 1999). These documented occurrences are not included within the Project Area but, this species is expected to occur in suitable habitats within the Project Area.

Porter's Sagebrush

Porter's sagebrush (*Artemisia porteri*) is listed as a sensitive species by Wyoming BLM. This species is a mat-forming perennial subshrub with numerous slender stems less than 15 centimeters tall. This species flowers in June and July. Porter's sagebrush is endemic to Wyoming and is restricted to the Wind River Basin and Powder River Basin in Fremont, Johnson, and Natrona counties. Suitable habitat includes sparsely vegetated badlands of ashy or tufaceous mudstones and clay slopes between 5,300 and 6,500 feet elevation. In the northern Wind River Basin, this species is found in semi-barren, low desert shrub communities dominated by Porter's sagebrush, birdfoot sagebrush, longleaf wormwood on dry, whitish, ashy-clay hills, gravelly-clay flats, and shaley erosional gullies of the Wagon Bed Formation (Fertig and Beauvais 1999).

Porter's sagebrush is known from eight extant populations in Fremont, Johnson, and Natrona counties (Fertig and Beauvais 1999). A single population documented in southwestern Johnson County is within the Project Area, and this species is expected to occur in suitable habitats within the Project Area.

Nelson's Milkvetch

Nelson's milkvetch (*Astragalus nelsonianus*) is listed as a sensitive species by Wyoming BLM. This species is a perennial herb with fleshy-leathery stems 10 to 30 centimeters tall. This species flowers from mid-May to late June. Nelson's milkvetch is regionally endemic to southwest and central Wyoming, northeast Utah, and northwest Colorado. In Wyoming, it is known from the Wind River, Green River, Washakie, southern Powder River, and Great Divide basins, Owl Creek Mountains, and the Rock Springs Uplift in Fremont, Natrona, and Sweetwater counties. Suitable habitat for this species includes alkaline, often seleniferous, clay flats, shale bluffs and gullies, pebbly slopes, and volcanic cinders. Known occurrences are found primarily in sparsely vegetated sagebrush, juniper, and cushion plant communities at elevations between 5,200 and 7,600 feet elevation (Fertig and Beauvais 1999).

This species is known from 24 extant populations all located on private lands within central Wyoming (Fertig and Beauvais 1999). Three populations are known from Johnson County, two of which are located in the eastern portion of the county that is within the Project Area. Therefore, this species is expected to occur in suitable habitats within the Project Area.

Many-stemmed Spider-Flower

Many-stemmed spider-flower (*Cleome multicaulis*) is listed as a sensitive species by Wyoming BLM. This species is a slender, glabrous annual forb with erect, unbranched or sparingly branched leafy stems 20 to 70 centimeters tall. This species flowers and sets fruit from June to August. Its global distribution includes central Mexico (near Mexico City) to southeast Arizona, southwest New Mexico, and southwest Texas, with disjunct populations in south-central Colorado and central Wyoming. Wyoming populations are restricted to the Sweetwater River Valley in Natrona County. In Wyoming, Many-stemmed spider-flower is found primarily on whitish, alkali-rich, strongly hydrogen-sulfide scented soils bordering shallow, spring-fed playa lakes or dried lakebeds. Populations are most abundant on damp, but not flooded, flats with approximately 90 percent cover of alkali-cordgrass, desert saltgrass, balti rush, Nuttall's alkaligrass, Nevada bulrush, and sea arrowgrass bordering playa lakes. This species may also be present in lower numbers on clayey dunes surrounding alkaline lakes with less than 50 percent cover of cordgrass, arrowgrass, and alkali sacaton or on low hummocks of greasewood. Small patches may also occur in dry alkaline depressions with 20 percent cover of saltgrass, cordgrass, plains sea-blite, smoot hawk's beard, and goldenweed. All Wyoming colonies occur at about 5,860 feet elevation (Fertig and Beauvais 1999).

This species is known from a single extant site in Natrona County (Fertig and Beauvais 1999). Because all known Wyoming populations of this species occur in Natrona County, this species is not expected to occur within the Project Area.

Williams' Wafer-Parsnip

Williams' wafer-parsnip (*Cymopterus williamsii*) is listed as a sensitive species by Wyoming BLM. This species is a tufted, perennial herb with basal, once-pinnately compound leaves and a flowering stalk five to ten centimeters tall. This species flowers from May through mid-June. Williams' wafer-parsnip is endemic and restricted to the Bighorn Mountains of north-central Wyoming in Bighorn, Johnson, Natrona, and Washakie counties. Suitable habitat includes open, south or east-facing ridgetops and upper slopes with exposed limestone outcrops or talus between 6,000 and 8,300 feet elevation. Soils tend to be thin, sandy, and often restricted to small cracks or pockets in limestone bedrock. Barren rock can provide up to 50 percent of total cover. This species is usually absent or very uncommon where grass cover is high or where western mountain mahogany and ponderosa pine are dominant. It also tends to be absent from lower slopes or valley bottoms with deeper or better-developed soils. Common associates include timber milkvetch, spatulate milkvetch, alpine bladderpod, whitlow-wort, and stemless hymenoxys (Fertig and Beauvais 1999).

This species is known from 23 extant populations found in the limestone or talus outcrops of the Bighorn Mountains (Fertig and Beauvais 1999). This species may occur in suitable habitats in Johnson County and, therefore, may occur within the Project Area.

Cary Beardtongue

Cary beardtongue (*Penstemon caryi*) is listed as a sensitive species by Wyoming BLM and Region 2 of the FS. This species is a glabrous perennial herb with flowering stems 10 to 40 centimeters tall. The flowering period for the Cary beardtongue is between May and July. This species is a regional endemic of the Bighorn and Pryor Mountains of north-central Wyoming (Big Horn, Sheridan, and Washakie counties) and south-central Montana. Suitable habitat for this species includes sparsely-vegetated calcareous rock outcrops and rocky soil within sagebrush, juniper, Douglas-fir, and limber pine communities. This species typically occurs at elevations between 5,200 and 8,500 feet. Observations in Wyoming suggest that the species does not favor areas of dense grass or shrub cover (Fertig and Beauvais 1999).

This species is known from 15 extant populations in the Bighorn Mountains (Fertig and Beauvais 1999). Four of these known populations occur in extreme western Sheridan County that is not within the Project Area. Therefore, this species is not expected to occur in the Project Area.

Laramie False-Sagebrush

Laramie false-sagebrush (*Sphaeromeria simplex*) is listed as a sensitive species by Wyoming BLM and Region 2 of the FS. This species is a mat-forming perennial herb or subshrub less than ten centimeters tall. This species flowers between May and August. It is endemic to southeast Wyoming in the western foothills of the Laramie Range, Shirley Basin, and Shirley Mountains (Albany, Carbon, Converse, and Natrona counties) (Fertig and Beauvais 1999).

This species is known from 11 extant populations that occur in Albany, Carbon, Converse, and Natrona counties (Fertig and Beauvais 1999). All of the known populations in Converse County occur in the southern portion of the county and south of the southern extent of the Project Area. Therefore, this species is not expected to occur within the Project Area.

Soft Aster

Soft aster (*Aster mollis*) is listed as a sensitive species by Region 2 of the FS. This species is a perennial, multi-stemmed herb averaging 30 to 50 centimeters high. This species flowers between July and mid-September. Soft aster is a Wyoming endemic restricted to the Bighorn Mountains (Big Horn, Johnson, Natrona, Sheridan, and Washakie counties) and Cliff Creek/Hoback Canyon area of Sublette County (Fertig et al. 1994). Jones (1984) also reports a specime*n of purple aster* from Fremont County "with possible influence of soft aster". Potential habitat may extend into Montana at the far northern end of the Bighorn Mountains in the Crow Indian Reservation. Suitable habitat for the soft aster includes primarily deep, rocky calcareous soils in dry mountain big sagebrush or shrubby cinquefoil grasslands and mountain meadows bordered by aspen or conifer woods at 6,400-8,500 feet elevation. Populations have also been documented from limestone outcrops and redbeds.

This species is known to occur from 34 extant populations found in the Bighorn Mountains (Fertig and Beauvais 1999). The documented populations found in Sheridan and Johnson counties are near the western boundary of the Project Area. Therefore, this species may occur in suitable habitats within the Project Area.

Northern Arnica

Northern arnica (*Arnica lonchophylla*) is listed as a sensitive species by Region 2 of the FS. This species is a perennial herb with solitary or loosely-clustered, glandular-hairy stems 17 to 40 centimeters tall. This species flowers in June and July. Its global distribution is from Alaska to Newfoundland, south to southern Alberta, Minnesota, and New Brunswick, with disjunct populations in Wyoming and South Dakota; these have been segregated as var. *arnoglossa* by some authors. In Wyoming, northern arnica is known from the Bighorn Mountains in Johnson, Sheridan, and Big Horn counties, with a vague, historical report from Washakie County. Suitable habitat in Wyoming is subalpine granite talus slopes and rocky meadows, montane limestone or granite talus slopes, montane Douglas-fir, limber pine, or Engelmann spruce slopes covered by dense moss, and Engelmann spruce riparian woods on mossy knolls and boulders between 5,300 to 10,300 feet elevation (Fertig and Beauvais 1999).

Northern arnica is known from nine extant occurrences in Wyoming with seven occurrences discovered since 1992 (Fertig and Beauvais 1999). The documented populations found in Sheridan and Johnson counties are near the western boundary of the Project Area. Therefore, this species may occur within the Project Area.

Hall's Fescue

Hall's fescue (*Festuca hallii*) is listed as a sensitive species by Region 2 of the FS. This species is a tufted perennial with stems (culms) 20 to 80 centimeters tall. The flowering period for this species is between May and July. Its distribution is from northern Alberta to Ontario, south to North Dakota and Colorado. In Wyoming, it is known from the Absaroka, Beartooth, Bighorn, and Medicine Bow Mountains in Albany, Johnson, and Park counties. Suitable habitat includes montane meadows, slopes, and edges of open coniferous woods and meadows at 6,800 to 11,000 feet elevation, usually on soils derived from calcareous parent material. It can occur at the edge between open meadows and lodgepole pine-Englemann spruce forests or in tundra. This species occurs with shrubby cicnguefoil, big sagebrush, timber eoatgrass, prairie lupine, prairie smokemountain death-camas, beardtongue spp. (Fertig and Beauvais 1999).

This species is known from ten confirmed records, eight of which are from Park County, and one from Johnson and Albany counties (Fertig and Beauvais 1999). One documented population in Johnson County occurs near the western border of the county, west of the Project Area. Because of the lack of suitable habitat conditions and the absence of any known occurrences within the Project Area, this species is not expected to occur within the Project Area.

Northern Blackberry

Northern blackberry (*Rubus acaulis*) is listed as a sensitive species by Region 2 of the FS. This species is a low, rhizomatous, perennial herb with non-bristly/prickly stems to 15 centimeters high. The flowering period for this species is from mid-June to July. Its global distribution is from Alaska to Newfoundland south to British Columbia and Minnesota, and in the Rocky Mountains from Montana to Colorado. In Wyoming, it is known from the east slope of the Bighorn Mountains (Johnson County) and Yellowstone Plateau (Teton County). Suitable habitat is in understory of moderate to dense canopy cover in spruce, spruce/willow, and occasionally willow-dominated communities (Fertig and Beauvais 1999).

This species is known from three extant populations, two populations in the Bighorn Mountains of northwestern Johnson County, and one population in Teton County (Fertig and Beauvais 1999). The known occurrences of this species do not occur within the Project Area. Because of the lack of suitable habitat conditions and the absence of any known occurrences within the Project Area, this species is not expected to occur within the Project Area.

Hapeman's Sullivantia

Hapeman's sullivantia (*Sullivantia hapemanii* var. *hapemanii*) is listed as a sensitive species by Region 2 of the FS. This species is a perennial forb with glandular-pubescent stems 5 to 60 centimeters tall. This species flowers from June to August. It is a regional endemic of southern Montana, north-central Wyoming, and central Idaho. In Wyoming, it is known from the Bighorn Mountains, Wind River Canyon, and northern Laramie Mountains in Big Horn, Johnson, Sheridan, Washakie, Hot Springs, and Natrona counties. Suitable habitat is considered moist calcareous outcrops and boulders in shady canyons and streams at 4,600 to 8,200 feet elevation (Fertig and Beauvais 1999).

This species is known from 26 extant populations near the Bighorn Mountains (Fertig and Beauvais 1999). The documented occurrences of this species in Sheridan and Johnson counties are near the western boundary of the Project

Area. Therefore, this species may occur in suitable habitats within the Project Area.

Special-Status Terrestrial Wildlife Species

Much of the information available for the following special status species is restricted to public lands, including lands administered by BLM, FS, and USFWS. Unfortunately, similar information is generally not available for privately owned lands. Therefore, the occurrence of the following special status species is unverified for much of the privately owned lands within the Project Area. Two published reports from the WGFD, *Atlas of Birds, Mammals, Reptiles, and Amphibians in Wyoming* (Luce et al. 1999) and *Threatened, Endangered, and Nongame Bird and Mammal Investigations* (Cerovski et al. 2000) were relied upon heavily for general species occurrence information within the Project Area. Unless otherwise noted, these special status species are expected to utilize suitable habitats within the Project Area.

Some of the following species that follow are not expected to occur within the Project Area. They are included because these species are on the BLM and FS candidate and sensitive species lists and occur near the Project Area.

U.S. Fish and Wildlife Service

Black-tailed Prairie Dog

Black-tailed prairie dog (*Cynomys ludovicianus*) was added to the list of candidate species for federal listing on February 4, 2000 (USFWS 2000a). At that time, the USFWS concluded that listing the black-tailed prairie dog was warranted but precluded by other higher priority actions to amend the lists of threatened and endangered species. No specific date for proposal for listing was given, but the USFWS has committed to reviewing the status of the species one year after publication of the above-mentioned notice (i.e. on February 4, 2001) (USFWS 2000b). As of October 2001, the candidate status of the black-tailed prairie dog status had not been changed by the USFWS (USFWS 2001d).

The black-tailed prairie dog is a highly social, diurnally active, burrowing mammal. Aggregations of individual burrows, known as colonies, form the basic unit of prairie dog populations. Found throughout the Great Plains in shortgrass and mixed-grass prairie areas (Fitzgerald et al. 1994), the black-tailed prairie dog has declined in population numbers and extent of colonies in recent years due to habitat destruction or disturbance, and pest control activities. In Wyoming, this species is primarily found in isolated populations in the eastern half of the state (Clark and Stromberg 1987). Many other wildlife species, such as the black-footed ferret, swift fox, mountain plover, ferruginous hawk, and burrowing owl are dependant on the black-tailed prairie dog for some portion of their life cycle (USFWS 2000b).

This species is considered a common resident, utilizing shortgrass and mid-grass habitats in eastern Wyoming (Luce et al. 1999). Active and inactive prairie dog colonies are known to occur within the Project Area. However specific population and occurrence pattern data are not available.

Preble's Meadow Jumping Mouse

Preble's meadow jumping mouse (*Zapus hudsonius preblei*) (PMJM) is a federally-listed threatened species, endemic to the Colorado Piedmont east of the Front Range in east-central Colorado, along the Laramie Mountains in southeastern Wyoming, and following the North Platte River to Douglas, Wyoming (USFWS 2001e). The subspecies has declined within its historic range most likely due to habitat destruction from urbanization, livestock grazing, and water diversions.

Little is known about the habitat requirements of PMJM except what has been revealed in recent unpublished reports and anecdotal information from small mammal studies in riparian areas. Apparently, this subspecies is restricted to multi-strata, stream-side vegetation often in association with willows (*Salix* spp.) and in areas of thick herbaceous undergrowth. Other studies of meadow jumping mice in the eastern half of North America have reported habitat associations with grassy vegetation of adequate herbaceous ground cover (Whitaker 1963) and moist lowlands areas as opposed to mesic uplands (Quimby 1951).

In Wyoming, PMJM have been documented in two counties: along Crow Creek at F.E. Warren Air Force Base (Laramie County), and in the Lodgepole Creek drainage within the Medicine Bow National Forest (Albany County) (USFWS 2001e). Northern and eastern distribution limits for this species are not firmly established. A recent report published by Wyoming Natural Diversity Database states this species has been documented in the North Platte and South Platte Riverbasins, with collection sites as far north as the town of Douglas, west to the town of Boxelder, and east to the vicinity of Slater (Beauvais 2001). This report also states that surveys for members of the same genus on the FS Thunder Basin National Grasslands were conducted in 2000 with no captures. Therefore, this species is not expected to occur within the Project Area.

Black-footed Ferret

Black-footed ferret (*Mustela nigripes*) is a federally-listed endangered species. The black-footed ferret historically occurred throughout Texas, Oklahoma, New Mexico, Arizona, Utah, Kansas, North and South Dakota, Montana, Wyoming, Nebraska, and Colorado (USFWS 1970). The black-footed ferret is closely associated with prairie dogs, depending almost entirely upon the prairie dog for its survival. The decline in ferret populations has been attributed to the reduction in the extensive prairie dog colonies that historically existed in the western United States. Ferrets may occur within colonies of white-tailed or black-tailed prairie dogs. The USFWS has determined that, at a minimum, potential habitat for the black-footed ferret must include a single white-tailed prairie dog colony of greater than 200 acres, or a complex of smaller colonies within a 4.3 mile (7 km) radius circle totaling 200 acres (USFWS 1989). Minimum colony size for black-tailed prairie dog is 80 acres (USFWS 1989). The last known wild population was discovered in Meeteetse, Wyoming. Individuals from this population were captured and raised in protective captive breeding facilities in an effort to prevent the species' extinction (Clark and Stromberg 1987).

Recent survey efforts in the Shirley Basin have identified a population at this former re-introduction site. This is the only known population in Wyoming

(Marinari 2001). Extensive efforts have failed to identify any existing wild populations of this species within the Project Area. This species is not expected to occur within the Project Area.

Bald Eagle

Bald eagle (*Haliaeetus leucocephalus*) is a federally-listed threatened species (USFWS 1995). Bald eagles occur throughout North America from Alaska to Newfoundland, and from the southern tip of Florida to southern California. In Wyoming, this species builds large nests in the crown of large mature trees such as cottonwoods or pines. Food availability is probably the single most important determining factor for bald eagle distribution and abundance. Fish and waterfowl are the primary sources of food where eagles occur along rivers and lakes. Big game and livestock carrion, as well as larger rodents (e.g., prairie dogs) also can be important dietary components where these resources are available (Ehrlich et al. 1988). This species is an uncommon breeding resident in Wyoming utilizing mixed coniferous and mature cottonwood-riparian areas near large lakes or rivers as nesting habitat (Luce et al. 1999). As reported in the WGFD Annual Completion Report 2000 (Cerovski et al. 2000), there were 97 nesting attempts in the state. This is the highest recorded number of nest attempts since 1978.

Eagles are expected to winter within areas of suitable habitat within the Project Area. Feeding areas, diurnal perches, and night roosts are fundamental elements of bald eagle winter habitats. Although eagles can fly as far as 24 kilometers (15 miles) to and from these elements, they primarily occur where all three elements are available in comparatively close proximity (Swisher 1964). Food availability is probably the single most important factor affecting winter eagle distribution and abundance (Steenhof 1978). Typically, fish and waterfowl are the primary food sources where eagles occur along rivers, lakes, streams, and dams. In Wyoming, the availability of carrion, particularly domestic sheep, is an important winter food source for wintering bald eagles.

This species is a documented breeder and winter resident of suitable habitats within the Project Area (Luce et al. 1999). Known bald eagle nests and winter roosts are distributed throughout the Project Area, as indicated by location data provided by the WGFD. These important areas are typically associated with river drainages or other large bodies of water with suitable trees for nesting and roosting.

Mountain Plover

The mountain plover (*Charadrius montanus*) is proposed for federal listing (USFWS 1999b). The USFWS has 60 days to seek input from three species experts, the public, scientific community, and Federal and State agencies. The USFWS published a 60-day extension to the comment period on April 19, 1999 (USFWS 1999c). In October 2001, the USFWS designated the mountain plover as a proposed threatened species (USFWS 2001d).

This species utilizes high, dry, shortgrass prairie with vegetation typically shorter than four inches tall. Within this habitat, areas of blue grama (*Bouteloua gracilis*) and buffalograss (*Buchloe dactyloides*) are most often utilized, as well as areas of mixed-grass associations dominated by needle-and-thread (*Hesperostipa comata*) and blue grama (Dinsmore 1983).

Nests consist of a small scrape on flat ground in open areas. Most nests are placed on slopes of less than five degrees in areas where vegetation is less than three inches tall in April. More than half of identified nests occurred within 12 inches of old cow manure piles and almost twenty percent were found against old manure piles in similar habitats in Colorado. Nests in similar habitats in Montana (Dinsmore 1983) and other areas (Ehrlich et al. 1988) were nearly always associated with the heavily grazed short-grass vegetation of prairie dog colonies.

Mountain plovers arrive on their breeding grounds in late March with egg-laying beginning in late April. Clutches are hatched by late June and chicks fledge by late July. The fall migration begins in late August and most birds are gone from the breeding grounds by late September.

In Wyoming, this species is a common breeding resident (Luce et al. 1999) and does occur within suitable habitats in the Project Area. Data compiled by the BLM office in Buffalo, Wyoming indicate mountain plover nesting has been documented sporadically throughout the Project Area, including northeastern Converse County, near Gillette, and Sheridan. The Wyoming Natural Diversity Database recently published the results of their 2001 survey efforts in the Powder River Basin of Wyoming (Keinath et al. 2001). During these surveys, nine sightings of mountain plovers were recorded, of which two where within the Project Area. Suitable habitat was identified in the Project Area, but characterized as limited and fragmented.

Boreal Western Toad

The southern population of the boreal Western toad (*Bufo boreas boreas*), occurring in the Medicine Bow Mountains, is listed as a USFWS candidate species and Region 2 of the FS lists it as a sensitive species (USFWS 2001d). This species ranges from southeast Alaska throughout British Columbia and Alberta southward through the northwestern United States. In Wyoming, this species occurs in two distinct populations. The northern population, not listed as a federal candidate species, ranges from mid to higher elevations of Yellowstone and Grand Teton National Parks, and the Bridger-Teton, western Shoshone, and Targhee National Forests. The southern population is restricted to a few isolated areas of the Medicine Bow National Forest. The southern population may be extirpated. In 2000, survey efforts located three individuals and did not observe signs of reproduction at historical breeding locations. Habitat for this species includes moist or wet areas of foothill, montane, and subalpine regions including subalpine meadows, aspen and spruce-fir forests, and all riparian habitats occurring between 8,000 and 11,900 feet elevation (USGS 2001). Adult toads are sometimes found in drier habitats when dispersing (Keinath and Bennet 2000). However, current distributions are not known north of Carbon County, south of the Project Area. This species is not expected to occur within the Project Area.

BLM, Forest Service, and Wyoming Game and Fish Department

Dwarf Shrew

The dwarf shrew (*Sorex nanus*) is listed as a sensitive species by Wyoming BLM and Region 2 of the FS. The WGFD categorizes this species as SSC3. This species is restricted to the Rocky Mountains from Montana to New Mexico and Utah to South Dakota, although this range is not continuous. Wyoming forms part of the core of its range. Suitable for this species is typically alpine and subalpine rockslides, but may also include spruce/fir bogs, coniferous forests, and open woodlands (Fitzgerald et al. 1994). However, records do exist from lower elevation habitats including shortgrass prairie, dry stubble fields, and pinyon-juniper woodlands (Clark and Stromberg 1987). It is known from relatively small, isolated, relict populations in the Medicine Bow and the Bighorn Mountains and in northwest Wyoming (Albany, Carbon, Park, Johnson, and Teton counties) (Welp et al. 2000). Clark and Stromberg (1987) expect that the range includes most of Wyoming, except the basins of northeast Wyoming and the southeastern grasslands. The WGFD characterize the dwarf shrew as a rare resident occurring in southern and western portions of the state (Luce et al. 1999). This species may occur in suitable habitats within the Project Area.

Long-eared Myotis

The long-eared myotis (*Myotis evotis*) is listed as a sensitive species by Wyoming BLM and categorized as SSC2 by WGFD. This species occurs throughout the western portion of North America south to Baja California. Wyoming is close to the eastern periphery of its range. Clark and Stromberg (1987) indicated that this species is distributed statewide, with records in Park, Bighorn, Teton, Platte, Fremont, Sublette, Natrona, Sweetwater, Carbon and Laramie counties. In sagebrush steppe habitat, such as Sweetwater County, they are probably limited to small stands of conifers. Preferred habitats include coniferous forests, including ponderosa pine and spruce-fir, forests, sagebrush shrublands, and grasslands (Luce et al. 1999). This species roosts in caves, buildings, and mine tunnels (Clark and Stromberg 1987). This species may occur in suitable habitats within the Project Area.

Fringed Myotis

The fringed myotis (*Myotis thysanodes*) is a BLM and Region 2 FS sensitive species and the WGFD categorizes it as SSC2. The main range of this species extends from British Columbia through western North America to southern Mexico. In Wyoming, this species is found along the eastern edge of the state from the Black Hills to Laramie in Weston, Platte, Albany, Sublette, and Laramie counties (Welp et al 2000). This species is associated with a variety of vegetation community types, including montane meadows, sagebrush shrublands, desert scrub, mixed grass prairies, and woodlands, although it appears to prefer coniferous forests (Fitzgerald et al. 1994). Caves, mines, and buildings are used as day and night roosts for colonies of up to several hundred individuals. This species may occur in suitable habitats within the Project Area.

Townsend's Big-eared Bat

Townsend's big-eared bat (*Corynorhinus townsendii* [*Plecotus townsendii*]) is listed as a sensitive species by Region 2 of the FS and categorized as SSC2 by WGFD. This species is most common throughout the western half of North America and occurs south into central Mexico. Although Wyoming forms part of the core of this main range, it is distributed sparsely throughout the state (Clark and Stromberg 1987). It has been recorded in Converse, Goshen, Platte, Crook, Fremont, Big Horn, Hot Springs, Sweetwater, Washakie, Park, and Johnson counties. Suitable habitats in Wyoming include deciduous forests, dry coniferous forests, sagebrush and other shrublands, shortgrass and mixed grass prairies, and juniper woodlands. This species utilizes caves, buildings and rock outcrops for day and night roosts and hibernation sites (Luce et al. 1999). This species may occur in suitable habitats within the Project Area.

Spotted Bat

Spotted bat (*Euderma maculatum*) is listed as a sensitive species by Wyoming BLM and Region 2 of the FS and the WGFD categorizes it as SSC2. This bat occurs in western North America from Mexico to the southern border of British Columbia. Wyoming is on the northeast periphery of its range (Welp et al. 2000). In Wyoming, a single documented occurrence of this species exists from near Byron (Clark and Stromberg 1987). Suitable habitat in Wyoming includes juniper and sagebrush shrublands, short- and mixed-grass prairies (Luce et al. 1999). Roosting sites in rock crevices and cliff complexes are also known to be important (Welp et al. 2000). This species is often described using cliffs over perennial water (Clark and Stromberg 1987). In Wyoming, its range typically excludes the eastern half of the state (Clark and Stromberg 1987). This species is not expected to occur within the Project Area.

White-tailed Prairie Dog

White-tailed prairie dog (*Cynomys leucurus*) is listed as a sensitive species by Wyoming BLM. This species occurs in parts of Colorado, Utah, Wyoming, and Montana. In Wyoming, it occurs in the western half of the state occupying grasslands, shrublands, and desert-grass communities (Clark and Stromberg 1987). In Wyoming, this is a common resident occupying sagebrush shrublands, and short- and mixed-grass prairie throughout much the state (Luce et al. 1999). This species is known to occur in suitable habitats within the Project Area, but specific population and occurrence pattern data are not available.

Water Vole

Water vole (*Microtus richardsoni* [*Arvicola richardsoni*]) is listed as a sensitive species by Wyoming BLM and categorized by WGFD as SSC3. The main range of this species lies north and west of Wyoming in the Pacific Northwest, extending well into Canada. Topographic features such as mountains and valleys act as barriers. In Wyoming, water voles have a highly disjunct, limited geographic range (Welp et al. 2000). Clark and Stromberg (1987) reported this species from Park, Big Horn, Hot Springs, Sublette, Lincoln and Uinta counties, and suggest that they also occur in portions of Sheridan, Washakie, and Johnson counties. Suitable habitats in Wyoming include low gradient streams bordered by overhanging banks in subalpine to alpine meadows or Douglas-fir forests. They also occasionally occur in burrows in alpine grassland. In the Owl Creek Mountains, voles are found along marshy creeks at 2800 to 3000 meters in aspen communities (Welp et al. 2000). This species is not expected to occur within the Project Area.

Wolverine

Wolverine (*Gulo gulo* [*Gulo luscus*]) is listed as a sensitive species by Region 2 of the FS and categorized as SSC3 by the WGFD. Distribution is boreo-arctic with southward extensions along major mountain ranges. Wyoming is on the southern periphery of the range. Documented occurrences in Wyoming exist for Fremont, Sheridan, Lincoln, Park, Sublette, and Teton counties and the species is suspected in Big Horn County. In summer and fall, wolverines are found in late-successional mixed subalpine fir, spruce, and lodgepole pine forests with closed canopies. Areas above timberline are used for denning, travel, and scavenging (Wyoming Game and Fish Department 1997). Wolverines descend to lower elevations in winter, perhaps to riparian areas (Welp, et al. 2000). This species is not expected to occur within the Project Area due to its limited range within the state.

Swift Fox

In January of 2001, the USFWS did not support listing this species as threatened under the Endangered Species Act (USFWS 2001a) based on new biological information. The swift fox (*Vulpes velox*) is currently listed as a sensitive species by Region 2 of the FS and categorized by WGFD as SSC3. The swift fox is found in short- and mixed-grass prairie habitats. It appears to prefer flat to gently rolling terrain. The swift fox preys on small rodents, rabbits, and birds. Pups emerge from the den in June. Dens are generally located along slopes or ridges that offer good views of the surrounding area (Fitzgerald et al. 1994). Where they are abundant, they occur at a density of one pair per 1,200 to 2,000 acres. Individuals may roam over 2,000 to 2,500 acres during a night of hunting (Clark and Stromberg 1987). In Wyoming, this species is considered a common resident utilizing grasslands in the eastern plains, agricultural areas, irrigated native meadows, and the banks of roads and railroads (Luce et al. 1999). This species may occur in suitable habitats within the Project Area.

American Marten

American marten (*Martes americana*) is listed as a sensitive species by Region 2 of the FS. Marten have a boreal distribution with southern extensions along major mountain ranges. Isolated populations occur on mountain ranges in Montana, and in the Bighorn Mountains of Wyoming. This species has been recorded in Park, Teton, Lincoln, Fremont, and Carbon counties, and is also known to occur in portions of Uinta, Sublette, Hot Springs, Big Horn, Sheridan, Washakie, Johnson and Albany counties (Welp et al. 2000). Currently, the Wyoming Natural Diversity Database tracks martens only in the Bighorn Mountains, which comprise a state endemic population restricted to Big Horn, Johnson, Hot Springs, Washakie, and Sheridan counties. Because it has been isolated from adjacent populations for possibly as long as 8,000 years, the Bighorn Mountains population is of significant management concern. Marten are specialized for a narrow range of habitats. They require late-seral stands of mesic conifers, especially those with a complex understory structure of more than 30 percent cover (Clark et al. 1989b; Buskirk and Powell 1994). Spruce-fir stands are preferred, but marten will also use stands of lodgepole and limber pine, especially if near-ground structures are abundant. They are rare or absent in ponderosa and pinyon pine habitats (Buskirk and Powell 1994). This species is not expected to occur within the Project Area.

Least Weasel

Least weasel (*Mustela nivalis* [*Mustela rixosa*]) is listed as a sensitive species by Region 2 of the FS. The main distribution of this species is in the upper Midwest of the U.S. and southern Canada. Clark and Stromberg (1987) suggest that the Wyoming population may be a disjunct relict about 200 miles from the nearest known contiguous population in Nebraska and South Dakota. Sagebrush shrublands occur throughout the entire Project Area, with the Bighorn Mountains and associated foothills as the only exceptions. Although common in the southern portions of the Project Area, larger more contiguous tracts of sagebrush occur in the northeastern, central, and eastern portions of the Project Area. Typical habitats include gentle rolling ridges dominated by sagebrush and grasses with sporadic riparian corridors of willow and cottonwood (Clark and Stromberg 1987). This species may occur in suitable habitats within the Project Area.

American Peregrine Falcon

American peregrine falcon (*Falco peregrinus anatum*) has been recently delisted as a federally protected species (USFWS 1999a). The WGFD categorizes this species as SSC3. This species occurs across North America utilizing a variety of habitats. The peregrine falcon is typically associated with open country near rivers, marshes, and coasts. Cliffs are preferred nesting substrate; however, tall man-made structures may be used (Spahr et al. 1991). Peregrines typically prey on birds such as waterfowl, shorebirds, grouse, and pigeons. In Wyoming, this species is a rare resident with most breeding records from the western portion of the state (Luce et al. 1999). This species may occur in suitable habitats within the Project Area.

American Bittern

American bittern (*Botaurus lentiginosus*) is listed as a sensitive species by Region 2 of the FS and categorized as SSC3 by WGFD. This species breeds from south-central British Columbia to Newfoundland. In the United States, this species nests in all western and northern states. The American bittern rarely wanders far from marshy, swampy areas (Kingery 1998). This species typically feeds on fish, aquatic invertebrates, and insects. In Wyoming, this species is an uncommon summer resident (Luce et al. 1999). This species has been observed throughout much of the state, including the Project Area (Luce et al. 1999).

White-faced Ibis

White-faced ibis (*Plegadis chihi*) is listed as a sensitive species by Wyoming BLM and Region 2 of the FS, and categorized as SSC3 by WGFD. This species nests from central Mexico to Louisiana and Texas and through the Great Basin, with isolated colonies in Alberta, New Mexico, California, Montana, North Dakota, Iowa, and Kansas. Preferred nesting habitat includes tall emergent vegetation such as bulrushes and cattails growing as islands surrounded by water deeper than 18 inches. Feeding habitats may include wet hay meadows and flooded agricultural croplands, as well as marshes and shallow water ponds, lakes, and reservoirs (Kingery 1998). This species primarily feeds on aquatic invertebrates and insects. In Wyoming, this species is an uncommon summer resident (Luce et al.1999). This species has been observed throughout much of the state, including the Project Area (Luce et al. 1999).

Trumpeter Swan

Trumpeter Swan (*Cygnus buccinator*) is listed as a sensitive species by the Wyoming BLM. This species breeds in southern Alaska, northern British Columbia, western Alberta, Oregon, Idaho, Montana, and Wyoming. Following habitat destruction and over-hunting, this species was close to extinction. Careful management and reintroduction practices have helped return population numbers to several thousand individuals (Udvardy 1977). Suitable habitats for this species include lakes and ponds with developed aquatic vegetation for feeding and nesting materials (Terres 1980). Trumpeter swans typically feed on aquatic vegetation, aquatic invertebrates, and insects. This species has been observed throughout the state, including the Project Area, but there was no reported evidence of nesting (Luce et al. 1999).

Northern Goshawk

Northern goshawk (*Accipiter gentiles*) is listed as a sensitive species by Wyoming BLM and Regions 2 and 4 of the FS and categorized as SSC4 by the WGFD. This species occurs from Alaska through the Rocky Mountains to New Mexico and in the mountains and forests of Washington, Oregon, and interior California (Udvardy 1977). This raptor typically prey on habitats, squirrels, ducks, and other birds. Northern goshawks nest in a variety of habitats including conifer and aspen forests, and occasionally cottonwood trees (Kingery 1998). This species is a documented breeding resident of Wyoming and the Project Area (Luce et al. 1999).

Merlin

Merlin (*Falco columbarius*) is listed as a sensitive species by Region 2 of the FS and categorized as SSC3 by WGFD. This species nests in boreal forests below treeline from coast to coast and along the western mountains south to Oregon, Idaho, and Montana. It winters in southern latitudes from the southern United States to South America (Udvardy 1977). In Wyoming, this species is an uncommon resident occurring in a diversity of habitats below 8,500 feet, including open country and coniferous forests (Luce et al. 1999). Merlin typically rely upon locally abundant small bird populations, but will also prey on toads, reptiles, and mammals (Welp et al. 2000). This species is a documented breeder throughout much of the state, including the Project Area (Luce et al. 1999).

Upland Sandpiper

Upland sandpiper (*Bartramia longicauda*) is listed as a sensitive species by Region 2 of the FS and categorized as SSC4 by WGFD. This species nests from Alaska to Maine, south to northwestern Oklahoma and the mid-Atlantic states. The upland sandpiper nests in mid- to tall-grasslands and croplands, utilizing the tall vegetation to hide the nest (Kingery 1998). In Wyoming, this species nests in grasslands in the eastern portion of the state (Luce et al. 1999). Upland sandpipers typically feed on insects, terrestrial invertebrates, and seeds. This species is an uncommon breeding resident occurring in suitable habitats throughout much of eastern Wyoming, including the Project Area (Luce et al. 1999).

Long-billed Curlew

Long-billed curlew (*Numenius americanus*) is listed as a sensitive species by Wyoming BLM and Region 2 FS and categorized as SSC3 by WGFD. This species occurs from southern British Columbia to Manitoba, southeast to Wisconsin, Illinois, and Kansas, south to northern California and northern Texas. The long-billed curlew nests on shortgrass prairies and feeds on insects and aquatic invertebrates in salt marshes, mud flats, and beaches (Udvardy 1977). In Wyoming, suitable habitat may include sagebrush shrublands, wet meadows, irrigated meadows, and agricultural areas (Luce et al. 1999). This species is an uncommon breeding resident occurring in suitable habitats throughout much of eastern Wyoming, including the Project Area (Luce et al. 1999).

Yellow-billed Cuckoo

Yellow-billed cuckoo (*Coccyzus americanus*) is listed as a sensitive species by Wyoming BLM and Region 2 of the FS, and categorized by WGFD as SSC2. This species once ranged throughout the United States, southern Canada, and Mexico. The range of the western subspecies has been dramatically reduced and mostly limited to California and Arizona (Kingery 1998). In Wyoming, this species is an uncommon summer resident occupying cottonwood riparian areas below 7,000 feet and urban areas. Typical prey include insects, especially hairy caterpillars. It has been recorded in most areas of the state except for the montane regions (Luce et al. 1999). This species may utilize suitable habitats within the Project Area.

Burrowing Owl

Burrowing owl (*Athene cunicularia*) is listed as a sensitive species by Region 2 of the FS and categorized as SSC4 by WGFD. This species occurs from south-central British Columbia eastward to southern Saskatchewan and south through most of the western United States. Burrowing owls primarily nest in rodent burrows, particularly prairie dog burrows, in grasslands, shrublands, deserts, and grassy urban settings (Kingery 1998). In Wyoming, this species uses grasslands, sagebrush and other shrublands, and agricultural areas. Burrowing owls typically feed on insects, rodents, lizards, and small birds. This species is a confirmed breeder throughout much of the state (Luce et al. 1999). This species is known to occur in suitable habitats within the Project Area.

Lewis' Woodpecker

Lewis' woodpecker (*Melanerpes lewis*) is listed as a sensitive species by Region 2 of the FS and categorized as SSC3 by the WGFD. This species occurs from southern British Columbia and Alberta south to northern Arizona and south-central California. Suitable habitat for this species includes pine-oak woodlands, oak or cottonwood groves in grassland and ponderosa pine forests (Udvardy 1977). In Wyoming, this species principally occurs in open ponderosa and lodgepole pine forests and savannah and recently burned forests with abundant snags or stumps, mainly below 9,000 feet elevation. It also uses aspen, mixed pine-juniper, and cottonwood riparian habitats. Mated pairs may return to the same nest site in successive years (Welp et al. 2000). This woodpecker is opportunistic foraging on locally and temporarily abundant insect populations during spring and summer and on fruits during fall and winter (e.g., ants, beetles, flies, grasshoppers, and tent caterpillars). It is known to occur throughout most of the state except for higher elevation mountain regions (Luce et al. 1999). This species may utilize suitable habitats within the Project Area.

Three-toed Woodpecker

Three-toed woodpecker (*Picoides tridactylus*) is listed as a sensitive species by Region 2 of the FS. This species occurs from Alaska across northern Canada to Newfoundland, south along the western mountains to the Oregon Cascade Mountains in the west and east to Arizona and New Mexico. Coniferous forests are suitable habitats, particularly forests near recent burns (Udvardy 1977). In Wyoming, this species utilizes lodgepole pine, Douglas fir, and Englemann spruce-subalpine fir. This species typically feeds on insects, wood-boring beetles and tree sap. This woodpecker has been observed in most regions of the state except for the northeastern grasslands (Luce et al. 1999). This species may utilize suitable habitats within the Project Area.

Loggerhead Shrike

Loggerhead shrike (*Lanius ludovicianus*) is listed as a sensitive species by Wyoming BLM. This species occurs from North America south of the coniferous forest region into Mexico (Udvardy 1977). The loggerhead shrike is typically associated with open vegetation types, including agricultural areas, sagebrush shrublands, desert scrub, pinyon-juniper woodlands, and montane meadows (Johnsgard 1986). In Wyoming, this species is a common summer resident utilizing pine-juniper, woodlands short- and mixed-grass prairies, and shrublands. Loggerhead shrike typically feed on grasshoppers and crickets as well as other insects, mice, and small birds. This species is known to breed throughout the state (Luce et al. 1999) and is known to occur in suitable habitats within the Project Area.

Golden-crowned Kinglet

The golden-crowned kinglet (*Rugulus satrapa*) is listed as a sensitive species by Region 2 of the FS. This species occurs in the northern United States and Canada occupying dense coniferous forests (Kingery 1998). In the western mountain chains, this species utilizes the Douglas fir and subalpine fir zones (Udvardy 1977). In Wyoming, this species occupies coniferous and aspen-conifer forests of western and central Wyoming (Luce et al. 1999). This species typically feeds on insects, tree sap, fruits and seeds. The golden-crowned kinglet is an uncommon resident of the northeastern portion of Wyoming (Luce et al. 1999) and may utilize suitable habitats within the Project Area.

Pygmy Nuthatch

The pygmy nuthatch (*Sitta pygmaea*) is listed as a sensitive species by Region 2 of the FS and categorized as SSC4 by WGFD. Distribution of this species seems to be related to the occurrence of ponderosa pine. This species is widespread from southern British Columbia eastward through the Black Hills, and south to Baja California and mainland Mexico (Udvardy 1977). In Wyoming, it occurs at scattered locations statewide during the winter. During the breeding season, it is associated with mountain habitats in coniferous forests at the periphery of the state. This species has been observed breeding in the Bighorn and Medicine Bow National Forests and in most other coniferous habitats within the state. Ponderosa pine woodlands in the Black Hills and in the Douglas / Guernsey regions have the best potential to support large groups of breeders (Welp et al. 2000). Pygmy nuthatches typically feed on insects and conifer seeds. This species may utilize suitable habitats within the Project Area.

Sage Thrasher

The sage thrasher (*Oreoscoptes montanus*) is listed as a sensitive species by the Wyoming BLM. This species occurs from south-central British Columbia to southern Nevada, Utah, through Texas and Oklahoma, and in the San Joaquin Valley of California (Udvardy 1977). In Wyoming, this species is a common summer resident breeding in sagebrush shrublands throughout the state (Luce et al. 1999). Sage thrashers typically feed on insects and some fruit. This species may utilize suitable habitats within the Project Area.

Sage Sparrow

The sage sparrow (*Amphispiza belli*) is listed as a sensitive species by the Wyoming BLM. This species occurs from Washington south to Baja California, and throughout the Great Basin (Udvardy 1977). The sage sparrow is a common summer resident in the Wyoming grasslands and shrublands typically feeding on insects and seeds (Luce et al. 1999). This species may utilize suitable habitats within the Project Area.

Baird's Sparrow

The Baird's sparrow (*Ammodramus bairdii*) is listed as a sensitive species by the Wyoming BLM. This species ranges from Alberta, Saskatchewan, and Manitoba and Montana to South Dakota (Udvardy 1977). In Wyoming, this species is an uncommon summer resident using shortgrass prairie habitats (Luce et al. 1999). Typical diet for this species consists of seed and insects. This species may utilize suitable habitats within the Project Area.

Brewer's Sparrow

The Brewer's sparrow (*Spizella breweri*) is listed as a sensitive species by the Wyoming BLM. This species ranges from British Columbia east to Saskatchewan, south to New Mexico, Arizona, and southern California (Udvardy 1977). In Wyoming, this species is a common summer resident occupying sagebrush shrubland, and other shrubland habitats throughout the state (Luce et al. 1999). Brewer's sparrow typically feed on insects and seeds. This species may utilize suitable habitats within the Project Area.

Northern Leopard Frog

The northern leopard frog (*Rana pipiens*) is listed as a sensitive species by the Wyoming BLM and Region 2 of the FS. This species is found throughout much of boreal Canada, south through the upper mid-west and central plains states, westward into Idaho, Nevada, northern Arizona, and New Mexico (Stebbins 1985). In Wyoming, this species occurs in cattail marshes and beaver ponds from the plains to montane conditions as high as 9,000 feet elevation (Luce et al. 1999). Adult leopard frogs typically feed on insects, invertebrates, and small vertebrates including tadpoles, snakes, and fish. This species may utilize suitable habitats within the Project Area.

Columbia Spotted Frog

The Columbia spotted frog (*Rana luteiventris* [*Rana pretiosa*]) is listed as a sensitive species by Wyoming BLM and Region 2 of the FS. This species occurs through much of British Columbia and in Washington, Oregon, Idaho, Montana, Nevada, Utah, and Wyoming (Stebbins 1985). Wyoming is on the eastern edge of the range, where it is known from Park, Teton, Lincoln, Fremont, Sheridan, and Sublette counties. The primary population is in the northwest part of the state, where it is contiguous with populations in Idaho and Montana (Welp et al. 2000). A glacial disjunct population occurs in the Bighorn Mountains about 100 miles to the east of the primary, contiguous population. It is confined to the headwaters of the South Tongue River drainage and its tributaries in Sheridan County (Garber 1994). In Wyoming, suitable habitats can be found in foothills and montane zones usually in the vicinity of permanent water such as ponds, sloughs, small streams, and beaver ponds. This species may avoid areas with warm stagnant water and dense cattails. It breeds in old oxbow ponds in which fish are absent, with emergent sedges in wet meadows at the edge of lodgepole pine forests (Garber 1994). Adult spotted frogs typically feed on insects, invertebrates and small vertebrates including tadpoles and other frogs. This species may utilize suitable habitats within the Project Area.

Wood Frog

The wood frog (*Rana sylvatica*) is listed as a sensitive species by Region 2 of the FS. This species ranges throughout much of Canada, through the Midwest and Atlantic states southward to Tennessee. Isolated populations occur in Wyoming, Colorado, Missouri, and Arkansas (Stebbins 1985). In FS Region 2, wood frogs occur only on the Medicine Bow/Routt and Bighorn National Forests (Welp et al. 2000). Both populations are likely glacial relicts. The Medicine Bow population occurs in the Medicine Bow Mountains in Albany and Carbon counties, and extends into northern Colorado. The Bighorn population occurs 225 miles to the north in the Dome Lake area of the central Bighorn Mountains in Bighorn, Johnson, and Sheridan counties (Welp et al. 2000). In Wyoming, this species is typically associated with ponds, slow-moving streams, and wet grass/sedge meadows that do not contain fish (Baxter and Stone 1985). It is also found in glacial kettle ponds within coniferous forest and in beaver ponds on first order streams (Garber 1994). The wood frog breeds on northern edges of small shallow ponds with emergent graminoids and willows at high elevations, usually above 8,000 feet elevation. This frog's diet mainly consists of invertebrates. This species is not expected to occur within the Project Area.

Milk Snake

The milk snake (*Lampropeltis triangulum*) is listed as a sensitive species by Region 2 of the FS. This western subspecies occurs in the western and central states from Montana southward to northern Texas, including isolated populations in Utah, Colorado, and New Mexico (Stebbins 1985). In Wyoming, this species is also known from scattered records in the Bighorn Basin, the east slope of the

Bighorn Range, and the Laramie Range in Albany, Big Horn, Washakie, Hot Springs, Platte and Goshen counties. It is also suspected to occur in Sheridan, Campbell, Crook, Weston, Niobrara, Converse and Natrona counties. In Wyoming, this species is found in diverse habitats from lowlands to mountains, grasslands to open forests, and wilderness to suburban. It often occurs in plains and foothills below 5,900 feet elevation, but is almost never found in the shortgrass communities of the plains (Welp et al. 2000). Diet of this snake typically includes small mammals, birds, lizards, snakes, and bird eggs. This species may occur in suitable habitats within the Project Area.

Grasshopper Sparrow

The grasshopper sparrow (*Ammodramus savannarum*) is categorized as an SSC4 by the WGFD. This species ranges from coast to coast south of the of boreal forest belt and mainly north of the southwestern deserts (Udvardy 1977). In Wyoming, this species is a common summer resident utilizing a variety of non-montane habitats including sagebrush shrublands, short- and mixed-grass prairies, wet meadows, and agricultural areas (Luce et al. 1999). This sparrow typically feeds on insects and seeds. This species may utilize suitable habitats within the Project Area.

Special-Status Aquatic Wildlife Species

Sturgeon Chub

In April of 2001, the USFWS announced the listing of the sturgeon chub (*Macrhybopsis gelida*) as endangered but was not warranted due to recent re-evaluations of distribution and population numbers (USFWS 2001b). Historically, the sturgeon chub was found throughout the Missouri River basin from the Yellowstone River in Montana and the Powder River in Wyoming, downstream through the Missouri River and into the middle and lower Mississippi River to Louisiana. In Wyoming, this species is restricted to the Lower Bighorn and Powder Rivers. Preferred habitat is above gravel bottoms within large, turbid, fast-moving rivers. Sturgeon chub are most abundant in gravel riffles, but sometimes are found in sandy bottom pools containing some gravel. Sturgeon chub usually occur in less than three feet of water, and eat primarily bottom-dwelling invertebrates. Chub spawn in late spring to midsummer when water temperatures are between 65 and 72°F. Spawning occurs within shallow rapids over gravel and rock. The Powder River in Wyoming supports the largest known reproducing population of sturgeon chub (Gerard 1999). This species has been documented in the Powder River from below Crazy Woman Creek up to the confluence with Salt Creek. Sturgeon chub were also documented to occur in Crazy Woman Creek above its confluence with the Powder River (Patton 1997) and, therefore, is known to occur within the Project Area (Table 3–46).

Yellowstone Cutthroat Trout

In February of 2001, the USFWS announced that the petition to list the Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) failed to present substantial information that listing of this species was warranted (USFWS 2001c). This species is listed as a sensitive species by the Wyoming BLM and Region 2 of the FS.

Streams immediately below and above Yellowstone Lake are the global stronghold for this taxon. It is native to the Yellowstone River drainage downstream to the Tongue River, including the Big Horn/Wind and Clarks Fork River drainages (Welp et al. 2000). This species is also found west of the Continental Divide in the Snake River drainage below Palisades Reservoir in Idaho and in Pacific Creek and other tributaries of the Snake River above the Gros Ventre River. It has been introduced to waters east of the Continental Divide (Baxter and Stone 1995). The Yellowstone cutthroat trout has been recorded from Teton, Park, Sheridan, Johnson, and Big Horn counties (Welp et al. 2000). Suitable habitats include coldwater rivers, creeks, beaver ponds, and large lakes. Optimum water temperature generally may be 4.5 to 15.5°C, but tolerance of much warmer temperatures probably occurred historically in larger rivers. Warm-water populations occur in some geothermally-heated streams (Gresswell 1995), including some at least 81°F in Yellowstone National Park (Clark et al. 1989b). This species may occur in suitable aquatic habitats within the Project Area (Table 3–46).

Cultural Resources

Regional Characterization

The Project Area is located in the Powder River Basin of northeast Wyoming and includes all of Campbell County, and large portions of Converse, Johnson, and Sheridan counties. The principal current land uses are ranching and energy development. For the purposes of analysis, this large area is subdivided into 18 watersheds. Current land use is dominated by ranches that raise cattle, sheep, and smaller numbers of bison, and by mineral and energy development. Coal mines are largest and most numerous in the eastern edge of the Project Area in the Fort Union Formation. In the past, the Project Area supported large herds of bison. Prior to Euroamerican settlement, the seasonal to irregular availability of water and general lack of sheltered areas discouraged large, permanent settlements.

Most of the central portion of the Project Area is underlain by lower Eocene sandstones, claystones, and coal beds of the Wasatch Formation. Smaller but locally extensive areas around the edges of the Project Area are underlain by Paleocene sandstones, shales, and coal beds of the Lebo, Tongue River, and Tullock members of the Fort Union Formation. Little high quality raw material for prehistoric stone tool manufacture occurs in these deposits. Local raw materials for stone tools are dominated by high quality klinkers produced through the metamorphosis of claystones by burning coal seams. Exotic raw materials from the Black Hills, the Hartville Uplift, the Bighorn Mountains, or more distant sources stand out from drab local materials.

Cultural Context

Cultural resource sites are defined as discrete locations of past human activity, which can include artifacts, structures, works of art, landscape modifications, and natural features or resources important to history or cultural tradition. These sites can include extensive cultural landscapes, such as farm or ranch landscapes, linear landscapes, such as historic trails with associated towns, forts and way stations, or railroad landscapes, and traditional use areas. In this document important sites (sites that will require additional consideration) include both listed and eligible sites (those sites that are listed on, determined eligible for, or recommended eligible for the National Register of Historic Places under the Criteria for Evaluation (36 CFR § 60.4) or National Landmarks) and sites that have not been evaluated. For the purposes of this analysis, unevaluated sites are considered potentially eligible, because they have not been determined to be not eligible, and therefore require avoidance or evaluative investigations.

Prehistoric

All recognized prehistoric cultural periods, from Clovis through Protohistoric (about 11,500 to 200 years ago), are represented to some extent in the project area. The broad prehistoric chronological periods used in this region are:

- Paleoindian Period (11,500 to 8,000 years ago)
- Early Plains Archaic (8,000 to 5,000 years ago)
- Middle Plains Archaic (5,000 to 2,500 years ago)
- Late Plains Archaic (2,500 to 1,500 years ago)
- Late Prehistoric and Protohistoric (1,500 to 200 years ago)

Approximately 10 percent of the Project Area has been investigated, primarily in the eastern portion of the Basin. In this small sample of the project area the earliest prehistoric cultural periods, Paleoindian through Early Plains Archaic, are represented by only a small number of sites. Archaic and later prehistoric period sites (Archaic to Protohistoric) are represented in increasing numbers as a result of higher populations through time and better preservation of more recent sites (Table 3–48).

Important prehistoric site types in the region include artifact scatters, stone circle sites, kill sites and faunal processing sites, rock alignments and cairns, and stone material procurement areas. The following prehistoric site types are used in the tabulation of known sites from a files search for the Project Area conducted through the Wyoming Cultural Records Office in Laramie.

Artifact Scatters – Artifact Scatters are predominantly scatters of stone tools and stone tool-making debris in this region, but also include ground stone, ceramics, and composite artifact scatters. These sites are important because they are often the only remnants indicating the presence of human activity. Artifact Scatters may provide information on chronology, subsistence, technology, settlement patterns, and resource choices, and help to understand past lifeways.

Camp – Camps are predominantly sites with artifact scatters and features or a range of artifact types that indicate habitation of the area. Camp includes sites that are listed in the files search as open camp, habitation sites, or artifacts and features. These sites are more often field evaluated as eligible than artifact scatters. These sites are important because they have the potential to yield information that can inform us on issues of settlement, subsistence, technology, chronology, and social organization by various prehistoric peoples. Camps may contain concentrations of associated tools and materials known as activity areas, hearths,

Table 3–48 Tally of Prehistoric Components by Sub-watershed

Sub –watershed	Paleo-indian	General Archaic	Early Archaic	Middle Archaic	Late Archaic	Late Pre-historic	Proto-historic	Total	Total (per-cent)
Upper Tongue River	2	2	2	5	8	20	4	43	3.6
Middle Fork Powder River	9	5	4	20	32	52	1	123	10.2
North Fork Powder River						1		1	.1
Upper Powder River	4	11	2	23	31	75	1	147	12.2
South Fork Powder River					2	3		5	.4
Salt Creek				1	1			2	.2
Crazy Woman Creek	1				8	6	2	17	1.4
Clear Creek	4			2	3	8		17	1.4
Middle Powder River	1	2		3	7	13		26	2.1
Little Powder River	9	10	5	21	51	96	12	204	16.9
Antelope Creek	11	5	18	25	49	86	4	198	16.4
Upper Cheyenne River	9	15	4	23	47	70	4	172	14.2
Total	59	66	40	157	299	545	42	1,208	100
Total (percent)	4.8	5.5	3.3	13.0	24.8	45.1	3.5	100	

Note: Data were available for Campbell, Johnson, and Sheridan counties only. Some sub-watersheds are not listed and others have only minimal data.

storage pits, or other clusters of materials that represent discrete episodes of human activity.

Multi-Component – Multi-component sites are predominantly artifact scatters and camps that contain evidence of use by different cultural groups or by the same group over different periods of time. These sites include diagnostic artifacts and potential for buried remains and are often considered eligible. These sites are important because they provide evidence of settlement and use of the land by a specific cultural group or for a specific time. Multi-component sites may provide information on the migrations of people or technology and help inform us on cultural use of the landscape.

Habitation Features – Habitation features are predominantly stone circle sites in this region, but also include open architecture, structures, lodges, and rockshelters. These sites are important because they are habitation sites that can provide evidence of the range of habitation structural types and preferences and may provide information on settlement patterns, seasonal use of the area, social organization, and past lifeways.

Rock Features – Rock features are predominantly cairns, hunting blinds, and rock alignments but can include any non-habitation rock feature such as a medicine wheel. These sites are important because they provide information on the variety of site types that are possible in the area. These sites may provide information on ceremonial uses in the area, subsistence, territorial markers, and cultural use of the landscape.

Bone – Bone sites are marked by the predominance of animal bone and include bone scatters, kill sites, and butchering sites. These sites are often encoded as eligible. In addition to animal bone, they frequently contain a variety of stone tools, some of which may be time diagnostic. They may also contain hearth or storage features which can yield dateable carbon and other organic materials that can yield important information about the age of the site, the season the site was used, plants that were used, or butchering and processing techniques. They are important because they may inform us on technology, subsistence, and social structure for various prehistoric peoples for identifiable temporal periods

Rock Art – Rock art includes pictographs (painted images) and petroglyphs (images that are carved, ground, incised or pecked into the rock surface) that depict iconography on stone surfaces. These sites are important because they depict iconography of prehistoric people and may provide information on ceremony or subsistence related topics. Many portions of the Project Area do not contain suitable rock surfaces for the production or preservation of rock art.

Lithic Source – Lithic source is location used for acquisition of stone suitable for chipped stone tool manufacture. These locations may be areas of bedrock outcrops containing usable stone, or may be areas where pebbles, cobbles, or boulders of raw material have been redeposited by past geological processes. These sites are important because they may inform us on resource choices and technology of prehistoric peoples. Some materials that were preferred for their appearance or the quality of tools that could be made from them may be found quite far form their sources. The distribution of culturally modified materials away from lithic source areas can provide important information on the movement or interaction of cultural groups over time.

Feature Only – The category Feature Only is dominated by hearth features that are found as isolated cultural remains but can include any non-architectural feature not in association with artifact scatters. These sites are important because they can provide chronological information and special use or temporary use areas for specific activities. This may provide information on resource choices and cultural use of the landscape.

Human Remains – Human remains are the osteological remains of the prehistoric inhabitants usually found as an internment. Human remains are important for many reasons. For anthropologists they can help provide information on the belief systems and social structures of past people. In addition, they are the remains of the people who once occupied the area and may provide information on ancestry, migrations, health, and basic biological information such as age at death, sex, and stature.

Prehistoric Cultural Landscapes -- Any setting that was used frequently or over a prolonged period of time by one or more cultural groups has the potential to be considered a cultural landscape. A cultural landscape is “a geographic area (including both cultural and natural resources and the wildlife or domestic animals therein), associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values” (Birnbaum 1996:4). Vernacular landscapes encompass cultural materials, cultural features, intentional or casual modifications to the landscape, and resources or physiographic features that made that landscape culturally important. Consequently an eligible landscape cannot be avoided and protected simply by avoiding cultural objects, features and structures. The entire location and setting must be considered in terms of the historic character, that is the sum of all visual aspects, features, materials, spaces associated with the historic context of the landscape.

Prehistoric site densities can vary from extremely high in some settings, such as certain ridgetops and areas near larger, more reliable drainages, to nonexistent in other settings. The factors affecting these differences in density are not always readily apparent. Sites are areas where the evidence of one or more episodes of past human activity is visible on the landscape. If a location is used by a large number of people, or repeatedly over a long period of time, lost or discarded cultural materials will accumulate and sediments may also be altered by the incorporation of organic materials. If the landform remains stable over time and is not degraded, deeply buried, or mechanically disturbed, the site will remain visible. Site density, that is the number of sites found in a given unit area, will be influenced by the size and number of groups that used the area and the extent or density of sought after resources. High site densities are often associated with locations that have a predictable abundance of particular resources, locations that have a moderate abundance of several distinct resources, or locations that are strategically located with access to several resource zones. Another factor that is frequently noted in site location is proximity to a reliable source of water. Other factors may be responses to seasonal conditions, such as winter camps with minimal snow accumulation that are sheltered from the wind, or summer camps on higher benches away from swarming bugs.

In the Protohistoric and early historic periods the Project area was the territory of numerous tribes including, the Arikara, Crow, Lakota/Dakota, Arapaho, Kiowa, Comanche, Blackfeet, Cheyenne, and Shoshone. The region was a crossroads for many different Plains tribes, some of which used the area on a regular basis, and others, which entered the region occasionally for particular resources. Numerous confrontations occurred in the area among tribal groups, and with Euroamerican settlers and emigrants passing through to other areas.

Historic

The historic period of the area falls within the last two hundred years, and begins with transient, widely separated incursions by explorers and fur traders. Exploration and the establishment of the Rocky Mountain Fur Trade intensified Euroamerican presence in the Powder River Basin in the early 1800s. Early market trade in the region was centered on bulk items such as furs and depended on river transport. Trading forts at Fort William (later known as Fort Laramie) and several major forts along the Yellowstone River were major centers with a dynamic system of smaller forts and periodic rendezvous. European and Indian trappers and traders ranged through the mountains and basin for furs and returned to the trading forts to exchange marketable goods for supplies. First hand accounts indicate that a significant part of many trappers' income was also spent on gaming and whiskey. For many years these trading forts were major focal points of Euroamerican activities in the region.

After the decline of the fur trade in the late 1830s several of the major emigrant trails of the 1840s and 1850s passed the south end of the Project Area along the North Platte corridor. Fort Laramie served as a major supply point along the Oregon, California, and Mormon trails and was a focal point for overland emigrants. Portions of the emigrant trails in the Fort Laramie region were notorious for predations by Pawnee and Lakota bands. In 1845 Fort Laramie was still controlled by the American Fur Company, but Colonel Stephen Kearney left a detachment of about 100 men to provide protection for emigrants stopping at the fort. This famous fur-trading post was purchased by the US government in 1849 to become the second regular military installation along the Oregon and California trails, the first having been Fort Kearny in Kansas. In 1851 Fort Laramie was the site of an historic general treaty with the plains tribes. The Fort Laramie Treaty Council of 1851 was the greatest gathering of plains tribes ever and though it was considered a success, it did not completely eliminate hostilities. Fort Laramie provided many important services to the overland immigrant such as protection, a place to stay in winter, health care, and mail. (Unruh 1992:156).

With the emergence of the Montana gold fields in the 1860s, trails were established through the Project Area. The mid to late 1860s were intense years in Wyoming, and in the Powder River Basin in particular. The first variant of the Bozeman Trail was tried in 1863 by a group of 46 wagons. This first wagon train was turned back by Cheyenne and Lakota near present-day Buffalo. Three wagon trains followed the route in 1864. One of the latter wagon trains, often called the Townsend Train, was attacked by Cheyenne near the Powder River, and several emigrants were killed. There were several competing expeditions from 1864 through 1866 to identify a better route for a trail to the Montana gold fields and many gold seekers set out on their own without an established trail. Among the competing expeditions were the Sawyer expeditions of 1864, and 1865-1866, which attempted to establish a trail through the Powder River Basin south of Gillette and through Sheridan. Sites associated with these expeditions have been documented in Campbell and Sheridan counties. The expeditions were harassed by groups of Arapaho, Cheyenne, and Lakota, and on several occasions were pinned down for days or weeks. It became a customary practice in this region for several years to circle the wagons at the end of the day, dig rifle pits around the perimeter, and post pickets around the wagons and livestock. No viable trail was established across the middle of the basin due to Indian predations, unreliable water sources, and difficult terrain.

The Bozeman route along the western edge of the basin proved more viable. There were many documented confrontations between native tribes and Euroamericans along the Bozeman Trail. Among the more famous were the Wagon Box Fight, the Fetterman Massacre, and the Crazy Woman Battle. The area around the crossing at Crazy Woman Creek was the site of many other skirmishes as well. Despite sustained problems with the native groups, the Bozeman Trail was used sporadically, and military forts were established to protect the wagon trains, including Fort Reno and Fort Phil Kearney. In the Fort Laramie Treaty of 1868 the tribes were granted control of the Powder River Basin, troops were withdrawn from the forts, and the trail was closed for several years.

Although east of the Project Area, the discovery of gold in the Black Hills by Lieutenant Colonel Custer in 1874 stimulated an influx of gold seekers and settlers into the Black Hills and Powder River Basin. The influx into the sacred Black Hills enraged the tribes. The tribes refused to negotiate or come into the agencies, and the United States launched major campaigns against the “hostiles” in 1876, with the troops out of Fort Fetterman, near present Douglas, following the Bozeman Trail north. With the major Plains Indian campaigns of the late 1870s, the tribes were driven out of the Powder River Basin and the Bozeman Trail reopened. The arrival of the railroad and the establishment of Cheyenne in 1867 had made the Powder River Basin more accessible, and with the removal of the Indian threat, settlers began to filter in. In 1878 and 1879 mail and stage service was established roughly following the Bozeman Trail. Other historic corridors crossing the Project Area in this period included the Black and Yellow Trail, the Texas Cattle Trail, and the Cheyenne-Deadwood Stage Road.

When the initial Homestead Act of 1862 was passed, the Project Area was Indian territory. In 1877 the Indian threat had been removed and the Desert Land Act was passed. The latter act allowed homestead entries as large as 160 acres, large enough for small livestock operations in this arid region. The first to take advantage of the reopening of the Powder River country were cattle ranchers. Some of the ranches also served as stage stops and roadhouses along the trails. Large, speculative cattle companies overwhelmed the public range land in the 1880s. Sheep also became important soon afterwards, and competed with the cattle. Relations between the sheep and cattle ranchers were strained. The large corporate cattle ranches, which utilized broad areas of open range, also competed for land with towns and homesteaders. The large cattle companies were devastated by the harsh winter of 1886-1887, and already strained relations with sheep ranchers, towns and homesteaders became worse. A major period of conflict in 1892 in

The entry of the Burlington Railroad in the 1890s made travel to the region quicker and less hazardous, and for a time homesteaders and small ranches prevailed. In 1909 the Enlarged Homestead Act was passed, allowing larger homestead entries and an additional surge of homesteaders and small ranchers entered the region. The Stock Raising Homestead Act of 1916, which had less stringent requirements for improvements than the Enlarged Homestead Act, followed this and with the end of the First World War many veterans moved west to claim vacant land. This continued increase in settlement was brought to an end by droughts and agricultural recession in the 1920s and the Great Depression of the 1930s. Many homesteads and small ranches failed, and those that survived did so by absorbing failed ranches and establishing larger and more viable expanses of land. Many more failed ranches and homesteads were bought or reclaimed by the government under the provisions of the Bankhead-Jones Land Utilization Act of 1937.

The Homestead Act of 1862 had included subsurface rights, especially mineral rights, with homestead patents. The later homestead acts partially or entirely reserved federal mineral rights while granting surface rights in the patent. Entries for mineral rights were handled under a separate patent system. The separation of surface and mineral rights and several changes in the mineral patent system have resulted in a complex hodge-podge of surface and subsurface ownership. Extensive areas also have contrasting subsurface mineral rights where different types of minerals are covered by different ownership or control. Areas of contrasting surface and mineral ownership, most often private surface and federal minerals, are referred to as split estate. Such areas are especially common in portions of the Project Area, and result in challenging management problems.

With the establishment of the railroads in the early 1890s coal mining was also emerging as an important element of the regional economy. Sheep and cattle production have remained important elements of the regional economy, but they have been surpassed by mineral and energy development. The onset of the First World War increased the market for oil and coal and these industries expanded. Energy exploration and production were not strongly affected by the agricultural recession of the 1920s. However, the depression of the 1930s did suppress the energy market until the outbreak of the Second World War.

Historic site categories documented for the Project Area are based on broad historic themes. The site categories used in the tables in this document are, Rural, Urban, Mining, Transportation, Military, Exploration, and Communication. Each of these site categories, the types of sites they include, and the importance they may have in history are discussed briefly below.

Rural sites include:

- Small and large ranch/agrarian core complexes
- Outlying ranch/agrarian features (field barns, machinery yards, stock shelters, loadouts, stock ponds or tanks, water control systems, stock herding camps, etc.)
- Homesteads/farmsteads

- Rural community buildings (grange halls, rural schools, rural churches, mercantiles, etc.)

This theme involves historic rural settlement from the expulsion of the Native American tribes in the late 1870s to the early 1950s. Settlement was initially focused around the new or reestablished forts and military camps along the Bozeman Trail. As military and civilian wagon roads and stage roads were established, settlements formed along those arteries. Large corporate ranches soon occupied open lands for grazing and homesteaders also began to spread through the region. There were several cycles of expanded settlement and failure that may be reflected in building styles and materials in surviving structures. More favorable locations were repeatedly reoccupied, and many of the earlier structures were destroyed or modified by later uses. In some cases, each occupation or use episode in a core complex is centered in a slightly different location, and the earlier episodes retain a degree of spatial and structural integrity. Some marginal locations may retain fairly unmodified sites reflecting discrete settlement episodes, although it is a common practice to reuse abandoned buildings for stock shelters or other purposes.

Important parts of rural settlement were rural community buildings including churches, schools, and community halls such as grange halls. In some cases all of these functions were combined in a single building that might be located on a State-owned section or on land provided by one of the landowners. These types of buildings were also commonly located in small communities that served the nearby farms and ranches, as well as serving as political or economic centers at various levels. Many of the rural community buildings began to fall into disuse with the development of motorized traffic and maintained public roads. This is clearly manifested in the centralization of public schools with the development of busing.

These kinds of sites are important for their association with the broad patterns of settlement and development in this region. They represent the homesteads, small and large ranches, small communities, and support facilities that characterized these patterns. Some are important because of their association with specific historic events or the contributions of persons important in history. Others are rare surviving examples representing once common patterns. Some may be important for their potential to yield information important in history that is not available in written documents.

Urban sites include:

- Urban Architecture/Buildings
- Courthouse; Government and Community Buildings
- Dance Hall; Saloon Café/Diner;
- Fairgrounds; Parks
- Home; House; Residence
- Hotel/Lodge;
- Store; Commercial Building
- Church;

- Power Plant;
- Warehouses

This theme involves the emergence of towns. Towns developed as commercial or political centers and are characteristically a mix of residential, commercial, and public buildings. Industrial or industrial support facilities may also be an important element of a town. As energy development and railroads entered the region, towns formed along or moved to the railroad as railheads and transfer points, or formed near mines or well fields as residential areas for laborers and as centers for supply and support services. Urban architecture is more varied than rural architecture, partly because there is generally a wider range of functions represented, and partly because a greater financial base is expressed in more current or elaborate styles. Urban buildings and structures may also exhibit more time sensitive styles than rural vernacular buildings and structures, and may be more easily associated with particular periods or themes.

Mining sites, which includes liquid mineral and energy development, include:

- Mine;
- Mining Support Facilities;
- Tipple;
- Loadout;
- Well Field;
- Energy Exploration

The mining theme includes energy and mineral development facilities. The most conspicuous of these facilities are surface mine complexes, loadouts, and tipples. Oil and gas facilities are generally more dispersed than surface mine complexes. Earlier mines were often abandoned and not reclaimed. Although foundations or deteriorated structures may remain, equipment was typically moved to new mine locations or salvaged over the years. Old mines and oil fields are best identified through mineral claims and public records. Even if little remains in the way of surface structures and associated artifacts, these sites reflect changes in mining strategy and technology in the patterns of landscape modification.
Transportation sites include:

- Overland Migration Corridor/Emigrant Trail;
- Inscriptions;
- Tie Hack Camp;
- Trail/Stage Route;
- Stage Station;
- Freight Road;
- Airstrip;
- Ferry;
- Bridge;

- Road;
- Railroad

This theme represents changes in the patterns and technology of transportation from early historic trails that often followed prehistoric trails, to the emergence of trucks and automobiles and maintained public roads. The early trappers trails and emigrant roads had locations along them that could be called points of convergence. These might be river crossings, low passes, water sources, sources of wood, areas of good pasture, or landmarks. Between these points the trails might vary with the season, the whim of the traveler, or other conditions, and were more like broad swaths across the landscape than marked roads or trails as we might envision today. With more regular freight wagon routes and stage lines, roads were improved and maintained. When the railroads entered the scene, these were necessarily engineered corridors that responded to a different set of economic needs and to different design constraints.

Military sites include:

- Military Camp/Cantonment;
- Blockhouse/Powder Magazine;
- Battlefield/Battle Site;
- Military Fort;
- Proving Grounds;
- Air Bases;
- Chemical and Weapons Depots;
- Missile Silos

The military theme covers evidence of military camps and installations, support facilities, and sites of battles, beginning with the military encampments of the 1860s up through the military facilities of the Cold War. In the project area military sites are clustered along the Bozeman Trail corridors. Many of these sites are not conspicuous on the landscape, but must be identified from historic accounts and detailed surface inspection.

Exploration sites include:

- Fur Trade Cabin;
- Trading Post;
- Trade Beads;
- Expedition Camps;
- Survey Marker

The theme of exploration covers early exploration of the region by fur traders, government expeditions, early travelers, and railroad or General Land Office surveyors. These sites may be comparatively small and transient but are generally either locations described in historic accounts that may or may not be marked by physical remains, or sites marked by distinctive early historic artifacts, including goods made for Indian trade or trapping paraphernalia.

Communication sites include:

- Telegraph/Telephone Lines;
- Pony Express Stations;
- Transmission Lines

These sites represent early communications systems and energy distribution systems. They may be marked by little more than occasional insulator fragments or remnants of crudely hewn poles. Pony Express stops often need to be identified from historic sources. Some were little more than a rural shack and a corral, others were located at existing ranches, and many others became stage stops, retaining little to identify them as Pony Express stops.

Other sites consist of site types that occur in small numbers in the Project Are and do not fall in any of the themes listed above. Sites that have been counted in this category include:

- CCC Camp/Conservation Site;
- Hatchery;
- Monument;
- Prison Camp;
- Lumber Mill;
- Timber Camp;
- Shooting Range;
- Burial/Cemetery/Grave;
- Cairns;
- Historic Camp;
- Dump/Trash Scatter

The Wyoming guidelines also define historic periods that crosscut the themes and site types listed above. The major periods are:

- Early Historic (AD 1800 to 1842)
- Pre-Territorial (AD 1842 to 1868)
- Territorial (AD 1868 to 1890)
- Expansion (AD 1890 to 1920)
- Depression (AD 1920 to 1939)
- Modern (AD 1939 to present)

Evaluation of the importance of historic sites, districts and landscapes must consider aspects of both theme and period in assessing the historic character and contributing attributes of the resources.

Native American Traditional Cultural Places

General ethnographies of the Lakota, Crow, Mandan, Hidatsa, Arikara, Cheyenne, Arapaho, Shoshone, and other tribes that may have had traditional ties to this region do not provide information on specific resources in the Project Area that are likely to be traditional cultural concerns. There are certainly prominent and identifiable places to the west in the Big Horn Mountains and to the east in the Black Hills area. Probably the most widely known examples would be the Big Horn Medicine Wheel and Devils Tower. The known sacred and traditional places offer some indications of the types of places valued by the Plains Equestrian cultures in the historic period. However, any identification of sacred or traditional localities must be verified in consultation with authorized tribal representatives.

Conspicuous landmarks, prominences, and high locations were often held in reverence. It would be reasonable to assume that Pumpkin Buttes, several of the more distinctive or isolated buttes throughout the Project Area, and distinct rock formations in the Middle Fork and Red Wall country were traditionally important places. Some of these natural features may have associated rock art, cairns, offering sites, vision quest sites, or other tangible evidence of traditional importance, while others may be embedded in oral traditions.

Distinctive natural water bodies and confluences of flowing streams and rivers were held by many tribes to be sources of power and inspiration, and mirrors of the inner spirit. The presence of flowing water or bodies of water and high isolated locations such as buttes in close proximity to one another were sometimes considered especially powerful or close to the spirits. These kinds of locations were commonly used for fasting or vision quests. Some vision quest sites that were used repeatedly over the generations have physical features, such as cairns, small stone circles, offerings, small clusters of stone, or stone alignments, in addition to the character of their physical setting.

At a smaller scale, traditional rock art marks localities that were important or sacred to past populations and the rock art itself is a traditional concern to most existing tribes. Similarly stone intaglios and effigies, some rock alignments, and many ancient rock cairns mark traditionally significant locations. Any location with cobble effigy figures, unusually small or large stone circles or medicine wheels, geometric stone alignments, or prominent cairns should be considered a potential sacred or traditional site. Tribes may also hold alignments and cairns associated with more mundane functions such as trails and game drives to be sacred or traditionally important, and may also consider most archaeological sites to be traditional cultural places important to their tribal identity. Several of the tribes that have traditional ties to the Project Area consider “tipi rings” (i.e., stone circle sites) to be sensitive sites that may have spiritual or sacred associations. Traditional tribal concerns can also include traditional gathering areas for medicinal and ceremonial materials.

Files Search

A files search for all four counties (Campbell, Converse, Johnson, and Sheridan) was conducted through the Wyoming Cultural Records Office database in late

March of 2001. This files search covers most investigations in the four counties through the year 2000. The database of cultural resource reports, cultural resource sites, and isolated finds was then narrowed to the project area and subdivided by sub-watershed. This database contains records for 8,120 cultural resource sites, and 2,831 isolated finds. Of the total cultural resource reports in the files search 2,359 were completed prior to 1983 when statewide standards were implemented for cultural resource investigations and reporting. Some of those earlier reports might not be considered adequate by current standards and must be reviewed individually to evaluate their adequacy. Nonetheless, they provide information that might not be otherwise available on the nature and distribution of prehistoric and historic resources. A comparison of the surveyed acres listed in the files search and the total acreage of the Project Area indicates that approximately 10 percent of the Project Area has been investigated. Using this information, estimates can be made of the quantity of significant cultural resource sites that are likely be encountered in the projected area of potential effect of the proposed oil and gas development.

Table 3–49 and Table 3–50 list the numbers of prehistoric and historic cultural resource sites that have been documented in each of the sub-watersheds in the Project Area by site type or historic theme, and by National Register evaluation. Table 3–51 lists the number of isolated finds documented in each of the sub-watersheds. The files search for this area contains a high proportion of sites that are unevaluated or for which information on evaluation is lacking – 35.6 percent for prehistoric and 35 percent for historic. The files search tables show 13 percent of the prehistoric sites and 9.6 percent of the historic sites as listed or eligible. Typically, when adequate information is available, about 10 to 15 percent of the documented sites in an area are evaluated as eligible.

Artifact scatters dominate prehistoric sites in the Project Area. When there is adequate information to evaluate this type of site, the majority are not eligible. However, complex sites and sites with buried levels and dateable materials/artifacts can yield important information. Prehistoric sites in the category of “camp” are a combination of artifacts and features, or a range of artifact types. These sites are more often field evaluated as eligible than simple artifact scatters. The small categories of multi-component/stratified, habitation features, rock features, bone beds/scatters, and rock art are high profile categories that are very often evaluated as eligible. Bone beds and stratified sites that are key in our understanding of all periods of Plains prehistory occur in the project area. Subwatersheds where there have been more studies and more follow up studies, such as Antelope Creek, Upper Cheyenne, and Upper Belle Fourche, have a lower proportion of unevaluated sites. This is especially true of large coal mine developments. Areas within some of the subwatersheds have more varied habitats, particularly attractive resources, or conditions more conducive to preservation, and are very rich in significant prehistoric sites. This includes the Upper Tongue, the Middle Fork Powder, the lower Antelope Creek Drainage, and the eastern portions of the Upper Belle Fourche.

Table 3–49 Prehistoric Site Types by Sub-watershed

Sub-watershed	Evaluation	Artifact Scatter[1]	Camp[2]	Multi-Component	Habitation Features[3]	Rock Features[4]	Bone[5]	Rock Art	Lithic Source	Features Only	Human Bone	Unknown	Total	%[6]
Little Bighorn River	Eligible	0	0	0	0	0	0	0	0	0	0	0	0	0
	Unevaluated	2	0	0	0	0	0	0	0	0	0	0	2	66.7
	Not Eligible	1	0	0	0	0	0	0	0	0	0	0	1	33.3
	Total	3	0	0	0	0	0	0	0	0	0	0	3	<.1
Upper Tongue River	Eligible	3	8	0	1	0	0	0	0	0	0	0	12	5.6
	Unevaluated	69	41	1	25	4	3	2	8	3	0	0	156	72.9
	Not Eligible	26	12	0	4	3	0	0	1	0	0	0	46	21.5
	Total	98	61	1	30	7	3	2	9	3	0	0	214	4.0
Middle Fork Powder River	Eligible	24	78	0	6	2	2	5	8	0	0	0	125	29.4
	Unevaluated	66	41	0	15	5	2	2	12	0	1	1	145	34.1
	Not Eligible	77	63	0	2	4	0	0	9	0	0	0	155	36.5
	Total	167	182	0	23	11	4	7	29	0	1	1	425	7.7
North Fork Powder River	Eligible	0	1	0	0	0	0	0	0	0	0	0	1	25.0
	Unevaluated	2	0	0	0	0	0	0	0	0	0	0	2	50.0
	Not Eligible	1	0	0	0	0	0	0	0	0	0	0	1	25.0
	Total	3	1	0	0	0	0	0	0	0	0	0	4	<.1
Upper Powder River	Eligible	1	43	0	2	0	6	0	0	0	0	0	52	6.5
	Unevaluated	124	81	1	22	0	3	0	5	4	0	0	240	30.0
	Not Eligible	288	199	0	12	4	2	0	2	2	0	0	509	63.5
	Total	413	323	1	36	4	11	0	7	6	0	0	801	15
South Fork Powder River	Eligible	2	0	0	0	0	1	0	0	0	0	0	3	17.4
	Unevaluated	4	5	0	2	0	0	0	0	1	0	0	12	52.2
	Not Eligible	4	3	0	0	0	0	0	0	0	0	0	7	30.4
	Total	10	8	0	2	0	1	0	0	1	0	0	22	.4
Salt Creek	Eligible	2	1	0	1	0	0	0	0	0	0	0	4	6.2
	Unevaluated	10	14	0	7	3	0	1	1	0	0	0	36	55.4
	Not Eligible	16	4	0	0	5	0	0	0	0	0	0	25	38.4
	Total	28	19	0	8	8	0	1	1	0	0	0	65	1.2

Table 3–49 Prehistoric Site Types by Sub-watershed

Sub-watershed	Evaluation	Artifact Scatter[1]	Camp[2]	Multi-Component	Habitation Features[3]	Rock Features[4]	Bone[5]	Rock Art	Lithic Source	Features Only	Human Bone	Unknown	Total	%[6]
Crazy Woman Creek	Eligible	3	5	0	2	0	1	1	0	0	0	0	12	12.2
	Unevaluated	14	15	0	12	0	0	1	2	0	0	1	45	45.9
	Not Eligible	19	10	0	7	4	0	0	0	0	1	0	41	41.9
	Total	36	30	0	21	4	1	2	2	0	1	1	98	1.8
Clear Creek	Eligible	3	6	0	3	0	0	0	0	0	0	0	12	9.7
	Unevaluated	10	14	0	27	2	3	0	2	1	0	1	60	48.4
	Not Eligible	24	10	0	5	9	0	0	4	0	0	0	52	41.9
	Total	37	30	0	35	11	3	0	6	1	0	1	124	2.3
Middle Powder River	Eligible	2	1	0	0	0	0	0	0	0	0	0	3	2.3
	Unevaluated	33	37	0	6	0	0	0	2	0	0	0	78	61.5
	Not Eligible	40	5	0	2	0	2	0	0	0	0	0	49	36.2
	Total	75	43	0	8	0	2	0	2	0	0	0	130	2.4
Little Powder River	Eligible	11	40	0	16	1	5	0	0	0	0	1	74	13.6
	Unevaluated	66	21	1	26	2	3	0	3	0	0	0	122	22.4
	Not Eligible	256	33	0	29	9	7	0	12	1	1	1	349	64.0
	Total	333	94	1	71	12	15	0	15	1	1	2	545	9.9
Little Missouri River	Eligible	0	1	0	0	0	0	0	0	0	0	0	1	5.3
	Unevaluated	2	1	0	2	0	0	0	0	0	0	0	5	26.3
	Not Eligible	6	7	0	0	0	0	0	0	0	0	0	13	68.4
	Total	8	9	0	2	0	0	0	0	0	0	0	19	.3
Antelope Creek	Eligible	53	122	1	20	0	2	0	2	2	1	0	203	23.0
	Unevaluated	125	49	0	28	14	3	1	0	5	1	0	226	25.6
	Not Eligible	298	104	0	38	11	1	0	2	0	0	1	455	51.4
	Total	476	275	1	86	25	6	1	4	7	2	1	884	16.1
Dry Fork Cheyenne River	Eligible	1	32	0	11	1	1	0	1	0	0	0	47	11.1
	Unevaluated	58	58	0	59	50	2	0	1	2	0	0	230	54.4
	Not Eligible	90	31	0	11	7	3	0	4	2	0	0	148	34.5
	Total	149	121	0	81	58	6	0	6	4	0	0	425	7.7

Table 3–49 Prehistoric Site Types by Sub-watershed

Sub-watershed	Evaluation	Artifact Scatter[1]	Camp[2]	Multi-Component	Habitation Features[3]	Rock Features[4]	Bone[5]	Rock Art	Lithic Source	Features Only	Human Bone	Unknown	Total	%[6]
Upper Cheyenne River	Eligible	8	28	0	5	2	3	0	0	0	1	0	47	9.4
	Unevaluated	51	30	1	19	2	2	0	5	0	0	0	110	21.2
	Not Eligible	289	47	1	12	5	4	0	3	0	0	0	361	69.7
	Total	348	105	2	36	9	9	0	8	0	1	0	516	9.4
Lightning Creek	Eligible	3	15	0	2	0	0	0	0	0	0	0	20	8.8
	Unevaluated	80	29	0	12	4	3	0	1	0	0	0	129	56.6
	Not Eligible	54	19	0	4	2	0	0	0	0	0	0	79	34.6
	Total	137	63	0	18	6	3	0	1	0	0	0	228	4.1
Upper Belle Fourche River	Eligible	15	26	0	25	2	0	0	0	0	0	0	68	9.0
	Unevaluated	109	33	1	53	23	8	0	7	5	0	1	240	31.7
	Not Eligible	284	88	0	63	10	1	0	3	0	0	0	449	59.3
	Total	408	147	1	141	35	9	0	10	5	0	1	757	13.8
Middle North Platte River	Eligible	2	19	0	7	0	1	0	0	0	0	0	29	11.9
	Unevaluated	21	36	0	48	17	0	0	0	1	0	0	123	50.6
	Not Eligible	40	31	0	8	5	1	0	5	0	0	0	91	37.5
	Total	63	86	0	63	22	2	0	5	1	0	0	242	4.4
Total Eligible Sites		135	426	1	102	8	22	6	11	2	2	1	716	13.0
Total Unevaluated Sites		846	505	5	363	126	32	7	49	22	2	4	1961	35.6
Total Sites		2792	1597	7	661	212	75	13	105	29	6	7	5504	100
Per cent of Total Sites		50.8	29.0	0.1	12.0	3.9	1.4	0.2	1.9	0.5	0.1	0.15	100	

Notes:

1. Artifact Scatters are predominantly lithic (i.e. chipped stone tool) scatters in this region, but also includes ground stone, ceramics, and composite artifact scatters.
2. Camp includes sites encoded as open camp, habitation, or artifacts and features.
3. Habitation Features includes stone circles, open architecture, structures, lodges, and rockshelters. The most common of the latter are stone circles.
4. Rock Features includes cairns, hunting blinds, rock alignments, and other non-habitation rock features.
5. Bone includes bone beds, bone scatters, kill sites, and butchering sites.
6. % is given as percent Eligible for each subwatershed and then percent of total sites represented by the subwatershed.

Table 3–50 Historic Site Types by Historic Theme and Sub-watershed

Sub-watershed	Evaluation	Rural	Urban	Mining	Transportation	Military	Exploration	Communication	Other	Unknown	Total	%
Little Bighorn River	Eligible	0	0	0	3	0	0	0	0	0	3	60
	Unevaluated	0	0	0	0	0	0	0	0	0	0	0
	Not Eligible	1	0	0	1	0	0	0	0	0	2	30
	Total	1	0	0	4	0	0	0	0	0	5	0.2
Upper Tongue River	Eligible	8	11	3	13	4	0	0	0	1	40	16.9
	Unevaluated	37	13	14	2	5	1	0	9	12	93	39.2
	Not Eligible	12	60	8	22	0	0	0	2	0	104	43.9
	Total	57	84	25	37	9	1	0	11	13	237	10.5
Middle Fork Powder River	Eligible	8	1	0	1	1	0	0	0	1	12	12.1
	Unevaluated	34	6	0	2	0	0	0	8	6	56	56.6
	Not Eligible	16	1	0	2	0	0	0	11	1	31	31.3
	Total	58	8	0	5	1	0	0	19	8	99	4.4
North Fork Powder River	Eligible	1	0	0	0	0	0	0	0	0	1	50
	Unevaluated	0	0	0	0	0	0	0	0	0	0	0
	Not Eligible	0	0	0	0	0	0	0	1	0	1	50
	Total	1	0	0	0	0	0	0	1	0	2	<.1
Upper Powder River	Eligible	10	0	0	13	2	0	0	3	1	29	8.5
	Unevaluated	74	1	2	3	4	1	0	10	23	118	34.7
	Not Eligible	120	0	2	13	0	1	0	49	8	193	56.8
	Total	204	1	4	29	6	2	0	62	32	340	15.1
South Fork Powder River	Eligible	1	0	0	1	0	0	0	1	0	3	18.8
	Unevaluated	1	1	0	0	0	3	0	1	1	7	43.7
	Not Eligible	2	0	0	4	0	0	0	0	0	6	37.5
	Total	4	1	0	5	0	3	0	2	1	16	.7

Table 3–50 Historic Site Types by Historic Theme and Sub-watershed

Sub-watershed	Evaluation	Rural	Urban	Mining	Transportation	Military	Exploration	Communication	Other	Unknown	Total	%
Salt Creek	Eligible	0	0	0	2	0	0	0	0	0	2	7.1
	Unevaluated	6	0	0	2	0	0	0	0	1	9	32.2
	Not Eligible	5	0	1	6	0	0	0	5	0	17	60.7
	Total	11	0	1	10	0	0	0	5	1	28	1.2
Crazy Woman Creek	Eligible	1	0	0	6	1	0	0	1	0	9	12.7
	Unevaluated	18	1	2	2	0	2	0	3	1	29	40.8
	Not Eligible	17	0	1	8	0	0	0	5	2	33	46.5
	Total	36	1	3	16	1	2	0	9	3	71	3.1
Clear Creek	Eligible	16	8	0	6	3	0	0	1	1	35	19.7
	Unevaluated	32	12	4	5	0	0	0	4	12	69	38.7
	Not Eligible	15	10	3	39	0	0	2	5	0	74	41.6
	Total	63	30	7	50	3	0	2	10	13	178	7.9
Middle Powder River	Eligible	2	0	0	0	0	0	0	0	0	2	5.5
	Unevaluated	18	0	0	0	0	0	0	1	0	19	52.8
	Not Eligible	7	1	0	2	0	0	0	5	0	15	41.7
	Total	27	1	0	2	0	0	0	6	0	36	1.6
Little Powder River	Eligible	9	0	0	0	0	1	0	0	0	11	5.8
	Unevaluated	49	2	0	2	0	0	0	6	5	64	33.7
	Not Eligible	66	2	2	10	0	0	0	22	13	115	60.5
	Total	124	4	2	12	0	1	0	29	18	190	8.4
Little Missouri River	Eligible	0	0	0	0	0	0	0	0	0	0	0
	Unevaluated	3	1	0	1	0	0	0	1	1	7	70
	Not Eligible	2	0	0	0	0	0	0	0	1	3	30
	Total	5	1	0	1	0	0	0	1	2	10	.4
Antelope Creek	Eligible	14	1	0	4	0	0	0	2	2	23	7.9
	Unevaluated	37	1	2	0	0	0	0	16	13	69	23.5
	Not Eligible	123	0	5	6	1	0	0	55	11	201	68.6
	Total	174	2	7	10	1	0	0	73	26	293	13.0

Table 3–50 Historic Site Types by Historic Theme and Sub-watershed

Sub-watershed	Evaluation	Rural	Urban	Mining	Transportation	Military	Exploration	Communication	Other	Unknown	Total	%
Dry Fork Cheyenne River	Eligible	3	0	0	2	0	0	0	1	0	6	4.1
	Unevaluated	50	0	0	3	0	0	0	20	7	80	54.8
	Not Eligible	32	0	1	4	1	0	0	18	4	60	41.1
	Total	85	0	1	9	1	0	0	39	11	146	6.5
Upper Cheyenne River	Eligible	4	0	0	1	0	0	0	3	0	8	4.8
	Unevaluated	13	0	0	2	0	0	0	7	8	30	18.0
	Not Eligible	85	0	1	7	0	0	0	35	1	129	77.2
	Total	102	0	1	10	0	0	0	45	9	167	7.4
Lightning Creek	Eligible	2	0	0	0	0	0	0	0	0	2	3.9
	Unevaluated	8	0	0	0	0	0	0	3	10	21	41.2
	Not Eligible	15	0	0	0	0	0	0	11	2	28	54.9
	Total	25	0	0	0	0	0	0	14	12	51	2.3
Upper Belle Fourche River	Eligible	17	0	0	5	3	0	0	1	1	27	8.6
	Unevaluated	37	1	4	4	0	0	0	9	18	73	23.3
	Not Eligible	130	3	4	10	0	0	0	47	19	213	68.1
	Total	184	4	8	19	3	0	0	57	38	313	13.9
Middle North Platte River	Eligible	0	0	0	4	0	0	0	0	0	4	5.6
	Unevaluated	34	0	0	1	0	0	0	8	1	44	61.1
	Not Eligible	14	0	0	4	0	0	0	4	2	24	33.3
	Total	48	0	0	9	0	0	0	12	3	72	3.2
Total Eligible Sites		96	21	3	61	14	1	0	14	7	217	9.6
Total Unevaluated Sites		451	39	28	29	9	7	0	106	119	788	35.0
Total Sites		1209	137	59	228	25	9	2	395	190	2254	100
Per cent Total Sites		53.6	6.1	2.6	10.1	1.1	0.4	<0.1	17.5	8.4	100	

Table 3–51 Number of Isolated Finds by Sub-watershed

	Isolated Finds			
Sub-watershed	Prehistoric	Historic	Unknown	Total
Little Bighorn River	1	0	0	1
Upper Tongue River	25	0	7	32
Middle Fork Powder River	82	2	14	98
North Fork Powder River	1	1	0	2
Upper Powder River	437	57	80	574
South Fork Powder River	1	10	8	19
Salt Creek	22	3	3	28
Crazy Woman Creek	13	4	5	22
Clear Creek	17	5	0	22
Middle Powder River	33	1	2	36
Little Powder River	227	8	25	260
Little Missouri River	2	0	0	2
Antelope Creek	462	24	127	613
Dry Fork Cheyenne River	137	2	20	159
Upper Cheyenne River	216	7	30	253
Lightning Creek	30	0	9	39
Upper Belle Fourche River	408	40	82	530
Middle North Platte River	111	1	29	141
Total	2,225	165	441	2,831

Rural/agrarian sites dominate known historic sites because that is where the majority of systematic surveys have been conducted. These include homesteads, farms, ranches, agrarian and ranching features, irrigation features, and rural residences. The principal exception to this is the Upper Tongue River sub-watershed in which a large number of urban buildings and structures have been documented in Sheridan. The next most common site type is transportation features, which includes trails, roads, bridges, railroads, stage stations, railroad stations, and related structures or features. Where historic military sites, early exploration sites, and early transportation sites have been recognized and documented, most are considered significant because of their associations with significant historic events. Urban buildings and structures are often recorded as part of surveys of significant historic buildings, rather than in response to unrelated actions. This also produces a moderately high proportion of sites evaluated as eligible. The Bozeman Trail, its several variants, and related sites, were highly significant in western history and retain a large number of well-preserved segments. The Outlaw Cave/Red Wall area of the Middle Fork Powder River is rich in prehistoric caves and rockshelters, premiere prehistoric rock art sites, prehistoric stone features, and historic sites that figure prominently in Western lore. The proportion of significant historic sites is high in most categories and these sites require additional work beyond basic field recording. In addition, many of the historic sites are unevaluated and require additional background or context research to assess their eligibility.

Native American Consultation

Federal legislation including but not limited to 36 CFR §800 implementing Section 106 of the National Historic Preservation Act, as amended, and the Native American Graves Protection and Repatriation Act (NAGPRA), requires consultation with recognized Native American tribes. Within the Project Area this includes the Apache, Northern Arapaho, Crow, Northern Cheyenne, Arikara, Mandan, Hidatsa, Kiowa, Shoshone, Salish and Kootenai, Turtle Mountain Chippewa, and Lakota (Sioux) tribes. The BLM has notified tribes that may have traditional interests and concerns in the region of the EIS process. A meeting hosted by the Cheyenne River Sioux and attended by members of the Cheyenne River Sioux Tribe and Oglala Lakota Tribe was held in South Dakota in April 2001 and the Sicangu Lakota Treaty Council of the Rosebud Sioux Tribe has expressed concern about the project. The tribes will be cooperating or consulting parties in the EIS process.

Land Use and Transportation

Land Use

This section discusses the existing land surface and mineral ownership, land uses, and land use management and planning in the Project Area.

Regional Characterization

The BLM-administered lands within the Project Area include both the BFOA and the CFOA. In Campbell, Johnson, and Sheridan Counties, BLM lands within the Project Area are administered by the BFO. For the northern potion of Converse County within the Project Area, BLM lands are administered by the CFO.

FS-administered lands in the Project Area include portions of the TBNG administered by the Medicine Bow-Routt National Forest. The TBNG is located in the eastern portions of Campbell and Converse Counties.

Land ownership in the Project Area consists primarily of private lands intermingled with federal and state lands as shown on Figure 3–15. Mineral ownership in the Project Area consists primarily of federal mineral estates as shown on Figure 3–16. Rangeland/livestock grazing is the dominant land use for both public and private lands in the Project Area. The management of planned future land uses within the Project Area is also discussed for BLM- and FS-administered lands, state-owned lands, and the local governments.

Land Status/Surface Ownership

The distribution of surface ownership of the land within each watershed of the Project Area is summarized in Table 3–52 and shown on Figure 3–15.

Approximately 76 percent of the surface ownership in the Project Area is private land. The State of Wyoming owns approximately 9 percent of the surface land ownership within the Project Area. Federal land comprises approximately 14 percent of the Project Area.

Federal lands within the Project Area are administered by the BLM BFO and CFO and the FS, and consist of numerous noncontiguous tracts of land surrounded by private lands. Approximately 10 percent of the lands within the Project Area are federally owned within the BFOA. Within the CFOA, approximately one percent of the land is federally owned. FS-administered lands in the area include portions of the TBNG administered by the Medicine Bow-Routt National Forest. The TBNG is located in the eastern portions of Campbell and Converse Counties. A total of approximately three percent of the lands within the FS-administered lands within the Project Area are federally owned.

Mineral Ownership

The mineral estate (mineral ownership) within the Project Area is shown in Figure 3–16. Many areas of the Project Area are considered to be "split-estate", meaning the surface owner is different from the owner of the mineral rights. For example, the surface may be privately owned but the mineral estate is at least in part, federally owned. In addition, there may be more than one owner among the different mineral estates. For example, the federal government may own only the oil and gas mineral resources, while coal and/or other mineral resources on the same lands are owned by the state or private parties. Under the current management situation, CBM is managed by the federal government as an oil and gas right, rather than a coal right.

The mineral ownership within each watershed in the Project Area is shown on Table 3–53.

The mineral ownership categories shown in Table 3–53 include several categories that must be combined to determine the total federal ownership for oil and gas rights. Total oil and gas ownership includes the sum of properties with federal ownership of all mineral rights; oil and gas rights only; oil, gas and coal rights only; and oil, gas, coal and other minerals (but not all mineral rights). The mineral category "other" includes locatable minerals (bentonite, uranium, and others) and salable minerals (sand, gravel and scoria).

The majority of the oil and gas mineral estates within the Project Area are federally owned. Within the BFOA, approximately 63 percent of the oil and gas mineral estate within the Project Area is federally owned. Approximately 63 percent of the oil and gas minerals for that portion of the Project Area within the CFOA are federally owned. Within the FS-administered lands of the Project Area, approximately 52 percent of the oil and gas rights are under federal ownership.

Existing Land Uses

Several primary land uses occur within the Project Area as shown on Figure 3–17**,** and as discussed in the following sections. The land use categories for the BLM-administered lands for both the BFOA and the CFOA, and the FS-administered lands within the Project Area are shown in Table 3–53**,** and summarized in the following discussion.

Figure 3–15 Surface Ownership

Figure 3–16 CBM Mineral Ownership

Table 3–52 Surface Ownership by Watershed

	Areal Extent (acres)						Portion of Project Area (percent)				
	Federal						Federal				
	BLM						BLM				
Watershed	BFO	CFO	FS	State	Private	Total	BFO	CFO	FS	State	Private
Little Bighorn River	425	0	0	3,671	45,489	49,585	1	0	0	7	92
Upper Tongue River	13,393	0	0	91,682	634,817	739,892	2	0	0	12	86
Middle Fork Powder River	149,835	0	0	47,905	266,716	464,456	32	0	0	10	57
North Fork Powder River	1,401	0	0	1,148	18,125	20,675	7	0	0	6	88
Upper Powder River	329,326	199	0	99,969	1,174,045	1,603,539	21	0	0	6	73
South Fork Powder River	31,849	0	0	8,452	74,056	114,357	28	0	0	7	65
Salt Creek	42,544	10,534	0	14,374	84,909	152,362	28	7	0	9	56
Crazy Woman Creek	55,585	0	0	65,106	427,599	548,289	10	0	0	12	78
Clear Creek	22,541	0	0	70,610	454,332	547,483	4	0	0	13	83
Middle Powder River	34,008	0	0	11,258	178,967	224,232	15	0	0	5	80
Little Powder River	75,216	0	43,024	59,324	687,928	865,492	9	0	5	7	79
Little Missouri River	378	0	6,932	2,932	28,286	38,528	1	0	18	8	73
Antelope Creek	735	27,172	101,373	48,509	482,517	660,306	0	4	15	7	73
Dry Fork Cheyenne River	0	20,825	46,093	106,843	218,645	392,405	0	5	12	27	56
Upper Cheyenne River	4,679	0	61,717	13,422	126,988	206,806	2	0	30	6	61
Lightning Creek	0	6,522	14,196	17,995	269,612	308,325	0	2	5	6	87
Upper Belle Fourche River	29,405	0	290	55,610	759,568	844,873	3	0	0	7	90
Middle North Platte Casper	0	28,500	0	14,251	169,825	212,576	0	13	0	7	80
Total	791,321	93,752	273,625	733,058	6,102,425	7,994,181	10	1	3	9	76

Table 3–53 Mineral Ownership

Watershed	Federal Coal	Federal Other	Federal Oil & Gas	Non-federal Oil & Gas	Total Oil & Gas	Portion of Area (percent) Federal Oil & Gas	Portion of Area (percent) Non-federal Oil & Gas
BFO							
Little Bighorn River	5,400	0	5,209	44,376	49,585	11	89
Upper Tongue River	343,088	772	142,412	597,481	739,892	19	81
Middle Fork Powder River	324,872	3,291	326,299	138,156	464,456	70	30
North Fork Powder River	13,782	0	14,776	5,898	20,675	71	29
Upper Powder River	1,407,909	986	1,092,495	507,509	1,600,004	68	32
South Fork Powder River	73,321	2,502	75,716	38,641	114,357	66	34
Salt Creek	98,097	0	98,732	26,362	125,093	79	21
Crazy Woman Creek	344,758	0	271,617	276,673	548,289	50	50
Clear Creek	325,853	384	173,022	374,461	547,483	32	68
Middle Powder River	205,941	0	153,922	70,310	224,232	69	31
Little Powder River	610,614	1	452,259	340,542	792,801	57	43
Little Missouri River	3,791	1	4,769	10,982	15,751	30	70
Antelope Creek	49,910	263	38,390	21,067	59,457	65	35
Dry Fork Cheyenne River	0	0	0	0	0	0	0
Upper Cheyenne River	47,388	343	27,143	27,608	54,751	50	50
Lightning Creek	0	0	0	0	0	0	0
Upper Belle Fourche River	663,769	1,424	323,341	499,584	822,925	39	61
Middle North Platte Casper	0	0	0	0	0	0	0
Total	4,518,494	9,966	3,200,101	2,979,651	6,179,751	52	48
CFO							
Little Bighorn River	0	0	0	0	0	0	0
Upper Tongue River	0	0	0	0	0	0	0
Middle Fork Powder River	0	0	0	0	0	0	0
North Fork Powder River	0	0	0	0	0	0	0
Upper Powder River	2,651	0	2,651	884	3,534	75	25
South Fork Powder River	0	0	0	0	0	0	0
Salt Creek	22,741	0	22,741	4,527	27,268	83	17
Crazy Woman Creek	0	0	0	0	0	0	0
Clear Creek	0	0	0	0	0	0	0
Middle Powder River	0	0	0	0	0	0	0
Little Powder River	0	0	0	0	0	0	0
Little Missouri River	0	0	0	0	0	0	0
Antelope Creek	179,960	121	155,170	75,652	230,821	67	33
Dry Fork Cheyenne River	104,365	565	100,987	56,384	157,372	64	36
Upper Cheyenne River	0	0	0	0	0	0	0
Lightning Creek	161,923	4,721	143,238	129,314	272,552	53	47
Upper Belle Fourche River	0	0	0	0	0	0	0
Middle North Platte Casper	144,288	485	140,933	71,643	212,576	66	34
Total	615,927	5,892	565,720	338,404	904,123	63	37
FS							
Little Bighorn River	0	0	0	0	0	0	0
Upper Tongue River	0	0	0	0	0	0	0
Middle Fork Powder River	0	0	0	0	0	0	0
North Fork Powder River	0	0	0	0	0	0	0
Upper Powder River	0	0	0	0	0	0	0
South Fork Powder River	0	0	0	0	0	0	0
Salt Creek	0	0	0	0	0	0	0
Crazy Woman Creek	0	0	0	0	0	0	0
Clear Creek	0	0	0	0	0	0	0
Middle Powder River	0	0	0	0	0	0	0
Little Powder River	47,645	10,281	47,645	25,047	72,691	66	34
Little Missouri River	11,185	2,990	11,185	11,592	22,777	49	51
Antelope Creek	311,821	15,149	247,687	122,341	370,028	67	33
Dry Fork Cheyenne River	109,509	15,415	94,887	57,061	151,948	62	38
Upper Cheyenne River	123,790	10,141	97,593	54,461	152,054	64	36
Lightning Creek	18,770	12,886	10,378	25,395	35,773	29	71
Upper Belle Fourche River	20,469	0	11,784	10,165	21,949	54	46
Middle North Platte Casper	0	0	0	0	0	0	0
Total	643,189	66,862	521,159	306,061	827,220	63	37
Grand Total	5,777,609	82,720	4,286,979	3,624,116	7,911,095	54	46

Figure 3–17 Land Use and Recreation Sites

Rangeland and Forest Land

Rangeland is generally used for livestock operations and grazing, and is the dominant land use in the Project Area. The primary use of the BLM- and FS-administered forest lands within the Project Area is also grazing. The forest land category shown on Figure 3–17 includes deciduous, evergreen, wetland/riparian, and mixed forest land.

Agriculture

Agricultural land uses within the Project Area include cropland and pasture, confined feeding operations, and other agricultural uses. Most of the cropland in the Project Area is not irrigated; however, irrigated cropland occurs in limited areas, primarily adjacent to drainage ways.

Urban and Residential

Urban land uses within the Project Area include residential, industrial/ commercial areas, and transportation, communications, and utility ROWs, as well as transitional areas, as shown on Figure 3–17**.**

Although rural residences are scattered throughout the Project Area, residences are primarily concentrated in the areas within and immediately adjacent to the incorporated areas of Project Area. The incorporated communities within the Project Area include Gillette and Wright in Campbell County; Douglas and Glenrock in Converse County; Buffalo and Kaycee in Johnson County; and Sheridan in Sheridan County. Additional residential areas within the Project Area are also concentrated in the vicinity of numerous unincorporated communities.

The transportation and utility corridors for the Project Area are shown on Figure 3–17**.** The transportation network and railroad corridors are discussed in the Section on Transportation.

Existing Oil and Gas Development

Approximately 12,077 CBM wells are already permitted or drilled on federal, state, and private lands within the Project Area. Existing CBM wells, non-CBM well, conventional oil and/or gas wells within the Project Area are discussed in the section on groundwater (beginning on page 3–1).

Mines

The locations of the coal strip mines within the Project Area are shown on Figure 2-1. Existing producing coal mines are discussed in the section on coal (beginning on page 3–38)**.** There are historic mines for coal, uranium, bentonite, and aggregate materials (sand and gravel) within the Project Area. Within the Project Area, oil and gas resources are frequently located in the same general vicinity as coal resources. Federal coal lands being considered as having development potential are primarily in the easternmost portion of the Project Area (BLM 2001).

Recreation

Recreational sites and facilities within the Project Area are discussed in the section on recreation (beginning on page 3–182) and shown on Figure 3–17**.** Public lands within the Project Area are generally available for dispersed recreational land uses. Several developed recreational facilities are located in special management areas (SMAs) on BLM-administered lands (see Table 3–61). Although no developed campgrounds are located in the FS-administered lands within the TBNG, this area provides land use opportunities for recreational activities.

Land Use Planning and Management

Land use planning and management are described generally in this section for lands administered by the BLM, FS, State of Wyoming, and the four counties encompassed by the Project Area. Public lands administered by the BLM and FS are generally available for oil and gas leasing, exploration and development.

Existing federal (BLM and/or FS) oil and gas leases within the Project Area contain various stipulations concerning surface disturbance, surface occupancy, limited surface use, and timing (seasonal) restrictions. These lease stipulations provide for the imposition of such reasonable conditions, not inconsistent with the purposes for which the lease was issued, as the BLM and or FS may require, to protect the surface of the leased lands and the environment. Mitigation measures can be imposed upon a lessee who pursues surface-disturbing activities; however, leased land without a No Surface Occupancy (NSO) or other similarly restrictive lease stipulation cannot be denied a permit to drill.

Within the Project Area, oil and gas estates are frequently located in the same vicinity as coal resources. Oil and gas leases are generally issued with special lease stipulations to help prevent a development conflict with coal. These stipulations may require as conditions of approval that a plan of mitigation of anticipated impacts be negotiated between the oil and gas and coal lessees prior to surface use. Coals mines in the Project Area are discussed under coal on page 3–38.

BLM Land Management

Overall BLM land management is described in detail in Chapter 5. Thus, this discussion focuses on more specific, smaller-scale management units.

Several BLM SMAs that provide recreational opportunities are located within the Project Area (Figure 3–17). These areas include the Fortification Creek SMA and Fortification Creek Wilderness Study Area (which is encompassed by the larger Fortification Creek SMA), and several additional Wilderness Study Areas (WSAs). Oil and gas leases are not issued with surface occupancy rights (for drilling, access routes, or production facilities) within WSAs to preserve the wilderness values. Surface disturbances are also restricted within Recreational Areas (RAs) and Wildlife Habitat Management Areas (WHMAs). WHMAs are managed in cooperation with the WGFD. The BLM land use planning and management goals for these areas are also discussed in the section on recreation (beginning on page 3–182).

Because oil and gas resources are frequently located in the same vicinity as coal resources, oil and gas leases are generally issued with special stipulations to help prevent a development conflict with coal resources. These stipulations may require that a plan of mitigation of anticipated impacts be negotiated between the oil and gas and coal lessees before surface use. The current BLM oil and gas stipulation (BLM 2001) prohibits or restricts surface occupancy or use within areas of conflict with ongoing coal mining activities. In addition to standard lease terms, special stipulations identifying specific terms and conditions of use may be attached to oil and gas leases, where needed to protect specific natural resources.

The BLM has also SMAs within the Project Area. They include the South Big Horns Area, the Dry Creek Petrified Tree Environmental Education Area, the Fortification Creek Area, the Weston Hill Recreation Area, and the Mosier Gulch Recreational Area. These SMAs were defined to manage for values and resources specifically identified with each SMA.

National Forest Land Management

Numerous land parcels within the TBNG are scattered throughout Campbell and Converse counties in the Project Area. Although the Bighorn National Forest is on the western boundary of the Project Area, none of the Bighorn National Forest lands are within the Project Area. Most of the CBM resources on the FS land within the Project Area are located in the westernmost portion of the TBNG.

Under the 1987 Federal Onshore Oil and Gas Leasing Reform Act, FS lands that are available for oil and gas leasing were identified, along with the stipulations that are considered to be appropriate to protect surface resources. The FS administers the land uses on National Forest System lands based on multiple use principals.

The Douglas Ranger District of the Medicine Bow-Routt National Forest administers the public lands and activities within the TBNG. Oil and gas leasing and development activities on FS-administered federal lands within the TBNG are allowed, subject to the limitations imposed by the LRMP for the Medicine Bow National Forest and TBNG (FS 1985). Actions proposed within the TNBG must be in conformance with the management goals within the LRMP (FS 1985).

The FS completed an FEIS and issued a ROD in 1994 for Oil and Gas Leasing on the TBNG (FS 1994). In 1994, the FS developed many special leasing restrictions for oil and gas activities within the TBNG. Leasing restrictions applicable to drilling or production activities within the TBNG may be included as conditions of approval for APDs on post-1994 leases. The restrictions outlined in the site-specific environmental effects analyses must contain documentation at to whether or not proposed development is consistent with the 1994 FEIS/ROD and the 1985 LRMP.

The 1999 Proposed LRMP for the TBNG (Forest Plan) provides the proposed land use guidelines for the eight management areas within the TBNG. Most of the FS land within the Project Area is managed for livestock grazing. The FS also has special stipulations to protect identified resources within FS-administered lands.

Federal Lands Grazing Allotments

Most of the BLM and FS lands within the Project Area are used for livestock grazing under permitted grazing allotments. Livestock grazing is not allowed in specified areas due to conflicts with other uses, such as big game winter ranges, and timber sale areas. Grazing allotments are classified by BLM into one of three management categories. These categories in priority order are: maintain (M), improve (I), and custodial (C). M category allotments have high production potential where no resource use conflicts have been identified. I category allotments have a high production potential but are producing below the potential level. C category allotments are generally isolated or scattered parcels of public land interspersed with nonfederal lands, and have little potential for multiple use management or positive economic returns. Most of the public land in the Project Area is in the M and I management categories.

Each BLM grazing allotment is classified by how many animal unit months (AUMs) are provided by the acreage in the allotment. AUMs are defined as the amount of forage to sustain one cow and calf for one month.

BLM requires land use activities within allotment areas to comply with the specific standards and guidelines for healthy rangeland in cooperation with the State of Wyoming (BLM 1997). Wyoming BLM Mitigation Guidelines (BLM 1995) are also employed to avoid and mitigate impacts and conflicts among resources and land uses for surface-disturbing activities on BLM-administered lands in Wyoming.

Wyoming State Land Management

The State Land Use Planning Act (W.S. 9-849 through 9-862) was enacted by the Wyoming legislature in 1975, and established the State Land Use Commission to guide land use planning in the state. The Office of State Lands and Investments, the administrative and advisory arm of the Board of Land Commissioners and State Loan and Investment Board, is responsible for oil and gas leases, and easements within and temporary uses of state lands.

The state-owned lands in the Project Area are generally available for mineral and agricultural leasing, timber leasing and sales, and public recreation. State Trust Lands are lands granted by the federal government to the State of Wyoming to generate revenues for the benefit of designated beneficiaries. These beneficiaries are the common (public) schools, universities, and other public institutions in Wyoming (Wyoming 1996).

The Wyoming State Land Commissioners, Office of Land and Investments, administers oil and gas leases and developments on state-owned lands in Wyoming. State Trust Lands are managed to generate revenues that are reserved for the benefits of designated beneficiaries, including the public schools, universities, and public institutions in Wyoming. State-owned lands in the Project Area are generally available for mineral and agricultural leasing and sales, and public recreation.

The WOGCC regulates drilling and well spacing, and requires an approved APD for all oil and gas wells drilled in the State of Wyoming regardless of land ownership, including wells on federal lands. The ADP approval process includes securing the necessary legal access to and /or across state- or privately-owned lands.

Campbell County Land Use Planning and Local Governments

Within Campbell County, the City of Gillette and the Town of Wright have zoning ordinances and land use plans for the incorporated areas. Planned future land uses within Campbell County are addressed in the City of Gillette/Campbell County Comprehensive Planning Program and shown on the Campbell County Zoning District Map (City of Gillette and Campbell County Planning Commission 1994). Adjacent to and outside of the city limits of the City of Gillette, Campbell County has designated zoning districts, including numerous subdivisions, and designated suburban and rural residential districts (Campbell County 2000a and 2000b). The unincorporated portions of the county outside of the Gillette Planning District are considered to be “Open District” zoning or agricultural (Bryson 2001).

Construction within the jurisdictional areas of the City of Gillette or other incorporated areas within the Project Area requires additional permitting with the local government agencies. The City of Gillette zoning regulations (City of Gillette 1992) define oil, gas and mineral exploration and production activities as “permitted uses” within the agricultural or heavy industrial districts within the city limits. Oil and gas production activities require City Council permission and must meet the applicable provisions in the Gillette Municipal Code. Permits are required from the City of Gillette for construction within the city limits, or the use of existing ROWs and easements dedicated or owned by the city. City noise ordinances would apply to drilling or construction operations within the city limits.

Numerous residential developments exist in the areas surrounding the City of Gillette, but outside of the incorporated area. If CBM development is proposed near any of these developments, current permitting requirements and stipulations would apply.

There are similar permits and mitigation measures would be required for CBM activities within the jurisdictional area of the Town of Wright (Town of Wright 1998) and other incorporated areas within the Project Area.

Johnson County Land Use Planning and Local Governments

Johnson County currently does not have a countywide zoning districts, land use districts, or a comprehensive land use plan, although they are in the process of developing one (Yingling 2001). The communities of Buffalo and Kaycee have land use plans for the urban areas. The Buffalo/Johnson Joint Land Use Plan was adopted August 2001, and is currently under revision. This plan primarily addresses land uses adjacent to the residential areas within less than ten miles from Buffalo.

The Powder River Conservation District Long Range Program Resource Conservation and Land Use Plan , adopted February 10, 1998 also provides land use guidance primarily to prevent erosion of soils for the southern half of Johnson County.

Sheridan County Land Use Planning and Local Governments

Development within the unincorporated portions of Sheridan County is regulated by the Sheridan County Zoning Resolution (Sheridan County 2001a), and the Sheridan County Growth Management Plan (2001b). With the exception of several designated growth areas in the vicinity of the existing residential developments, the anticipated future land uses and current zoning for most of the county is agricultural (Springer 2001). Designated growth areas are defined for the areas in the immediate vicinity of the City of Sheridan, Town of Clearmont, and the unincorporated urban and residential communities of Story/Banner, Big Horn, Big Goose Valley, Ranchester/Dayton, and Arvada (Sheridan County 2001b). The City of Sheridan has designated zoning districts for the incorporated areas (City of Sheridan 2000).

Within Sheridan County, a buffer zone area of several miles adjacent to and east of the Big Horn National Forest is designated as a Resource Conservation Area on the Sheridan County Comprehensive Plan Land Use Map (Sheridan County 1999). In addition, a low-density development area is identified surrounding the City of Sheridan, including and extending south of the community of Big Horn. These planning areas are not currently addressed in the Sheridan County Zoning Resolution (Sheridan County 2000b).

Converse County Land Use Planning and Local Governments

The Project Area is within the northwestern portion of Converse County and north of Interstate 25. Within the Project Area, the Converse County Land Use Plan (Converse County 1978) describes the current land use as primarily agriculture, predominantly dryland (nonirrigated) grazing. Mineral extraction is the current secondary use for this portion of the county. Mineral extraction is exempted from local regulations; however, mineral processing is regulated to minimize conflicts between mineral extraction and historic surface land uses. Converse County does not currently have countywide zoning. The city zoning ordinances for Douglas and Glenrock have development requirements (Musselman 2001a).

Transportation

The existing public road network, BLM roads, county transportation planning, and other transportation are discussed in the following sections. Scenic byways, areas designated for off road vehicle (ORV) use, and historic transportation corridors, are discussed in the Section on Recreation. Public lands are accessible via public roads and/or across private land that requires landowner permission.

Public Road Network

Gillette and Sheridan are the hubs for the transportation network in the Project Area. Interstate highways in the Project Area include I- 25 and I-90. The major north-south transportation corridors include State Route 59 in Campbell and Gillette Counties, and I-25 in Johnson and Sheridan Counties. The principal east-west highway for Campbell and Johnson Counties is I-90. I-90 runs north from the Town of Buffalo to the City of Sheridan, and then continues north to the Montana State line. U.S. Highways in the Project Area include U.S. Routes 14, 16 to the East of Buffalo, and 87. The Primary State Highways in the Project

Area are Routes 59, and 387. Secondary State Highways traversing the area include Routes 50, 51, 192, 196, 338, and 450. Numerous county roads also provide local access to public and private lands within the Project Area.

Recent annual average daily traffic counts (ADT) suggest use of highways and roads in the Project Area is highly variable (Table 3–54). Not surprisingly, the Interstates and major highways account for the highest ADTs.

BLM Road Design and Maintenance

There are numerous improved and unimproved (four-wheel drive) roads within the Project Area. BLM transportation planning for both the Buffalo and Casper resource districts is discussed in the 1985 RMPs, and in the updates to these documents (BLM 1985a and b, 2001a and b).

Table 3–54 Annual Average Daily Traffic Counts

			Annual ADT	
County	Route Name	Description	1998	1999
Campbell	I-90	Sheridan-Johnson County Line	5,700	5,970
	I-90	Wyodak Intersection	5,660	5,790
	I-90	Gillette East Urban Limits	5,970	6,100
	I-90	WYO 59 Int.	6,070	6,380
	US 14-16	Rozet Intersection	5,100	5,320
	WYO 50	Savageton	500	550
	WYO 59	Gillette South of Urban Limits	18,690	17,760
	WYO 59	Johnson-Campbell County Line	1,110	1,210
	WYO 59	Wright	2,150	2,250
	WYO 59	Converse-Campbell County Line	1,350	1,450
	WYO 59	Wyoming-Montana State Line	300	300
	WYO 387	Johnson-Campbell County Line	1,110	1,210
Converse	I-25	Platte-Converse County Line	5,500	5,980
	WYO 59	Bill	1,350	1,450
Johnson	I-90	Junction US 25 (Buffalo Tri-level Intersection)	3,680	3,700
	I-90	Johnson-Campbell County Line	5,030	5,140
	I-25 & US 87	Junction Kaycee Interchange	2,800	2,802
	US 16	Johnson-Sheridan County Line	260	280
Sheridan	I-90	Sheridan-Johnson County Line	5,700	5,970
	I-90 & US 87	Wyoming-Montana State Line	3,710	3,760
	US 14-16	I-90	2,400	2,400
	US 14-16	Ucross Junction	560	560
	US 14-16	Sheridan-Campbell County Line	180	180
	WYO 336	Sheridan East Urban Limits	4,100	4,200
	WYO 338	Sheridan North Urban Limits	1,050	1,050

Source: WDOT 1999

Based on the BLM Manual, Section 9113 (BLM 1985c), roads on BLM lands are classified, based on the amount of traffic movement, into three road classes, consisting of temporary, resource, local, and collector roads. Collector roads generally provide access to large land tracts and are the major access routes into development areas with high average daily traffic rates. They usually connect with or are extensions of public road systems and are operated for long-term land uses. Local roads normally serve a smaller area and lower traffic volume than collector roads. They connect with collectors or public road systems. In mountainous terrain, local roads may be single lane roads with turnouts. Resource roads are generally point access or spur roads that connect with local or collector roads, and carry low traffic volumes.

BLM minimum road design and maintenance requirements are provided in BLM Manual Section 9113 – Roads (BLM 1985c) and the BLM Wyoming Supplement (BLM 1991). Road routes, locations, and design criteria are included in the APD and/or ROW applications. For oil and gas roads, the operators must provide the BLM with copies of all road maintenance agreements. Because some operators do not need access to sites during winter months, snow removal is generally a separate maintenance agreement item.

State of Wyoming Road Access Permits and Maintenance

Prior to construction of new roads that are to access an existing state or county road, an access permit must be obtained from the Wyoming Department of Transportation (WYDOT). The application form for an access permit must include location of proposed road construction, and roadway design specifications, including type of surface material, drainage structures, roadway width, profile and grades.

Snow removal operation performed by the WYDOT is primarily mechanical, using snow plows, and fences (Milburn 2001b). An aggregate (sand) and salt mixture is generally used for tunnels and areas requiring deicing.

Many of the existing roads within the Project Area are in need of repairs and/or improvement. In the 2000 Surface Transportation Improvement Program (STIP) compiled by the WYDOT Planning Program, more than 200 highway improvement projects to begin for the year 2000. Major improvements projects scheduled for roads within the Project Area, in the Primary highway category, include widening and resurfacing a section of I-90 west of Gillette. In the Secondary highway category, scheduled improvements include seven miles of US 14-16 northwest of Clearmont, and four miles of WYO 335 between Big Horn and Sheridan. The STIP also provides a projection of the transportation improvements scheduled to occur in the five-year-plus period beginning in 2001.

County Transportation Planning

Transportation plans and goals for the four counties in the Project Area are discussed in this section.

The general planning goals for transportation for Campbell County are discussed in the City of Gillette/Campbell County Comprehensive Planning Program (City of Gillette and Campbell County 1994). Traffic generation and potential conflicts will be considered in evaluating new developments and zoning changes. The County is currently replacing scoria-surfaced roads with river gravel to reduce dust.

Currently, Johnson County has no formal transportation plan.

In Sheridan County, the Comprehensive Plan (Sheridan County 1982) provides a proposed transportation plan for improvement of the roads only for the City of Sheridan and the adjacent growth management area.

Transportation issues identified in the Converse County Land Use Plan (Converse County 1978) include paving and other road improvements that may be required due to increased traffic from increased rural residential development and mineral extraction and processing in rural areas. Gravel roads were previously suitable.

Other Transportation

Rail service and airports within the Project Area are discussed in the following sections.

Rail Service

The Project Area has one major railroad. In Sheridan County, the Burlington Northern/Santa Fe Railroad runs north-south from the Montana State line through the City of Sheridan, and then east through Clearmont, and continues east to the City of Gillette in Campbell County. The railroad then travels east of the City of Gillette, and runs north-south through Converse County. Several spur lines connect the railroad with historic mines in the area. In the BFOA, the average ROW width for the railroad is 400 feet (BLM 2001).

Airports

Three public airports exist in the Project Area (AirNav.com 2001). The Gillette-Campbell County Airport is located approximately four miles northwest of Gillette. The VOR (radio aid used for navigation) is located at the airport. The Sheridan County Airport is located on the west side of the City of Sheridan. All development within the Sheridan County designated Airport Zone must comply with the Airport Master Plan (Sheridan County 1975). The Johnson County Airport is located approximately three miles northwest of Buffalo.

Federal Aviation Administration (FAA) regulations require a two-mile radius safety zone around airports to promote air navigational safety at the airport, and to reduce the potential for safety hazards for property and for persons on lands near airports. FAA regulations also require filing a notice (FAA Form 7460-1) for construction projects which extend 200 feet or greater above natural terrain and located within five miles of an airport. Portions of Project Area are located within two-mile safety zones for these airports.

Visual Resources

Regional Characterization

The Project Area consists of public, state and private lands in Sheridan, Campbell, Johnson, and part of Converse County in northern Wyoming. The Project Area lies in the Powder River Basin portion of the Great Plains physiographic province and is bordered by the Big Horn Mountains to the west and the Black Hills to the east.

The Project Area landscape is comprised of open grasslands, low rolling hills, and unobstructed views of many miles. Most of the Area is covered with dryland vegetation consisting of grasses and shrubs. Ponderosa pine covers large portions of the northeast quarter of the Project Area. Outside the urban areas of Sheridan, Gillette, Buffalo, and Wright, the Project Area is characterized by a rural landscape that has been modified by oil and gas field developments, coal mines, grazing, and urban areas. Grazing activities are evident in most of the Project Area. Highways, county roads, private roads, and utility lines also are evident throughout the Project area. Portions of the Project Area remain natural and undeveloped in character despite widespread mineral development and grazing activities. Most of the Project Area landscape is composed primarily of scenery that is common for the region.

General Visual Characteristics

Oil and gas pumping units and associated well pads and access roads are evident throughout the Project Area. The majority of existing well development occurs in the eastern half of the Project Area in 40 and 80-acre well spacing patterns. Well development is most evident in Campbell County between the cities of Gillette and Wright, and north, west, and northwest of Gillette. Development is also evident along Interstate 90 and State Highway 14 and 93 in Campbell and Sheridan Counties. The landscape that has resulted from ongoing oil and gas development in this area is rural/industrial in character. The wells are intrusive (defined as readily visible) and visually dominant in foreground (one-quarter to one-half mile from observer) views from roads and trails. In middleground (generally one-half mile to three miles) and background (more than three miles) distance zones, well pads and associated access road clearings are the most obvious feature of oil and gas developments. Clearings are visible as light brownish gray exposed soils in geometrically shaped areas with straight, linear edges that provide textural and color contrasts with the surrounding undisturbed vegetation. In general, oil and gas facilities are visually subordinate to the landscape in middle to background distance zones.

The majority of areas with significant scenic values occur in the western part of the Project Area. The South Big Horns Area is located in the southwest quarter of Johnson County, primarily within the Middle Fork Powder River sub-watershed. The area provides sensitive and unique resource values, including scenery. Special management areas within the South Big Horns Area include the Middle Fork Recreation Area, the Red Wall/Hole-in-the-Wall area, Outlaw Cave, Dull Knife Battlefield site, and the Gardner Mountain and North Fork Wilderness Study Areas. The Powder River breaks in eastern Johnson County, the Fortification Creek SMA and WSA, and the Weston Hills Recreation Area in the eastern part of the Project Area also provide scenic settings for a variety of dispersed recreational activities.

There are two scenic byways in the western part of the Project Area that provide access to the Bighorn Mountains. The Bighorn Scenic Byway is on U.S. Route 14 west of Ranchester. The Cloud Peak Skyway is on U.S Route 16 west of Buffalo.

Visual Resource Management

BLM

The BLM has inventoried visual resources for all BLM, state and private land in the Buffalo and Casper Field Office areas according to the Visual Resource Management (BLM 1986b) and established VRM classes. The VRM system is the basic tool used by the BLM to inventory and manage visual resources on public lands. The VRM classes are objectives that outline the amount of disturbance an area can tolerate before it no longer meets the objectives of the class. There are four VRM classes, each of which combine and evaluates visual quality, visual sensitivity of the area, and view distances. The inventory includes state, National Forest, and private lands as well as BLM lands, however the BLM manages visual resources only on BLM lands. Many private and public lands in the area have increased in sensitivity since the last inventory conducted in the 1970s as a result of increases in population and lifestyle shifts that emphasize outdoor recreation. Four VRM classes have been inventoried within the Project Area, as shown on Figure 3–18 and summarized in Table 3–55. The objectives of VRM classes applied to lands within the Project Area are:

- Class II — Class II provides for activities that would not be evident in the characteristic landscape. Contrasts are seen, but must not attract attention. Lands along the base of the Bighorn Mountain foothills in the western part of the Project Area, and lands along Interstate 90 and State Route 14 in the Upper Powder River Sub-watershed are Class II lands. These lands are sensitive to public view.
- Class III — The objective is to provide for management activities that may contrast with the basic landscape elements, but remain subordinate to the existing landscape character. Activities may be visually evident, but should not be dominant. Class II areas occur primarily along major highway corridors such as Interstates 25 and 90, State Route 14, Fortification Creek SMA and WSA, and along a broad corridor at the base of the Big Horn Mountains between Buffalo and the Montana/Wyoming state line.
- Class IV — The objective is to provide for management activities that may require major modifications to the existing landscape. The level of change to the landscape can be high and may be visually dominant. Most of the Project Area is managed with Class IV objectives.
- Class V — This class is applied to areas where the landscape character has been so disturbed that rehabilitation is needed. It should be considered an interim short-term classification until one of the other classes can be reached through rehabilitation or enhancement. Lands currently managed with Class V objectives occur in the vicinity of urban areas of Sheridan, Buffalo, Gillette, and at coal mining areas in the eastern part of the Project Area.

Table 3–55 VRM Inventory for Sub-watersheds in the Powder River Basin Project Area

	Class II		Class III		Class IV		Class V		
Sub-watershed	acres	%	acres	%	acres	%	acres	%	Total
Little Bighorn River	33,315	67.2	16,270	32.8	0	0	0	0	49,585
Upper Tongue River	94,710	12.8	281,987	38.1	352,643	47.7	10553	1.4	739,892
Middle Fork Powder River	265,727	57.2	42,511	9.2	155,788	33.5	429	0.1	464,456
North Fork Powder River	18,901	91.4	1,774	8.6	0	0	0	0	20,675
Upper Powder River	49,484	3.1	183,977	11.5	1,370,078	85.4	0	0	1,603,539
South Fork Powder River	0	0	24,805	21.7	89,551	78.3	0	0	114,357
Salt Creek	0	0	9,634	6.3	142,728	93.7	0	0	152,362
Crazy Woman Creek	53,720	9.8	74,739	13.6	419,830	76.6	0	0	548,289
Clear Creek	40,519	7.4	133,702	24.4	370,443	67.7	2818	0.5	547,483
Middle Powder River	0	0	0	0	224,232	100	0	0	224,232
Little Powder River	0	0	90,611	10.5	746,929	86.3	27953	3.23	865,492
Little Missouri River	0	0	150	0.4	38,378	99.6	0	0	38,528
Antelope Creek	0	0	33,209	5.0	627,097	95.0	0	0	660,306
Dry Fork Cheyenne River	0	0	31,345	10.1	277,975	89.9	0	0	309,320
Upper Cheyenne River	0	0	0	0	183,947	89.0	22859	11.1	206,806
Lightening Creek	0	0	64,528	20.9	243,797	79.1	0	0	308,325
Upper Belle Fourche River	11,320	1.3	93,620	11.1	695,155	82.3	44778	5.3	844,873
Middle North Platte Casper	0	0	0	0	212,576	100	0	0	212,576
Total	567,696	7.2	1,082,862	13.7	6,151,147	77.8	109390	1.4	7,911,096

Table 3–56 shows the distribution of 12,077 CBM wells already permitted or drilled on federal, state, and private lands in the Project Area. The majority of permitted wells (10,218 wells, or nearly 85 percent) are on private lands, which is consistent with the distribution of surface ownership in the Project Area (see Land Use and Transportation – Affected Environment). Out of the total VRM inventory of 12,077 wells, only 205 wells (1.7 percent) are on BLM lands. The remaining wells are on state (1,535 wells) or National Forest lands (118 wells). Nearly 84 percent of permitted wells, regardless of land ownership, are in the VRM Class IV inventory.

Coal mining occurs primarily in the east-central part of the Project Area, east and south of Gillette. There are currently 14 active open-pit coalmines in Campbell County, and one coalmine north of the city of Sheridan. Open pit mining results in landscapes that have been altered considerably from the natural topography, consisting of significant contrasts from exposed soils and spoil piles with surrounding vegetation, dust from mining operations, and associated infrastructure such as buildings, rail haulage, and road systems. Coal mines dominate foreground and middleground views in the affected viewsheds, and are generally classified with VRM Class IV or V objectives in the Project Area.

Forest Service

The Medicine Bow-Routt National Forest has developed a Final Land and Resource Management Plan (LRMP) for the TBNG (FS 2001). The Forest has inventoried visual resources under the new Scenery Management System (SMS), which incorporates viewing distance zones, concern level (public importance), scenic attractiveness (indicator of intrinsic scenic beauty of a landscape), scenic class (determined by combining the scenic attractiveness with distance zone and concern levels), and existing scenic integrity (state of naturalness).

Scenic Integrity Objectives (SIO) were assigned to each management area based on the intent of the management area direction. SIOs provide goals for management of grassland and forest scenic resources. There are five SIOs ranging from

Figure 3–18 Visual Resource Management Classes

Table 3–56 Existing Wells in VRM Classes by Sub-watershed in the Powder River Basin Project Area

	Class II		Class III		Class IV		Class V		Total	
SubWatershed	Existing CBM Wells	Disturbance (acres)	Existing CBM Wells	Disturbance (acres)	Existing CBM Wells	Disturbance (acres)	Existing CBM Wells	Disturbance (acres)	Existing CBM Wells	Disturbance (acres)
Little Bighorn River	0	0	0	0	0	0	0	0	0	0
Upper Tongue River	323	1,454	86	387	406	1,827	0	0	815	3,668
Middle Fork Powder River	0	0	0	0	0	0	0	0	0	0
North Fork Powder River	0	0	0	0	0	0	0	0	0	0
Upper Powder River	182	819	197	887	2,429	10,930	0	0	2,808	12,636
South Fork Powder River		0		0		0		0	0	0
Salt Creek	0	0	0	0	0	0	0	0	0	0
Crazy Woman Creek	0	0	126	567	24	108	0	0	150	675
Clear Creek	12	54	234	1,053	143	644	0	0	389	1,750
Middle Powder River	0	0	0	0	727	3,272	0	0	727	3,272
Little Powder River	0	0	12	54	1,563	7,034	238	1,071	1,813	8,158
Little Missouri River	0	0	0	0	0	0	0	0	0	0
Antelope Creek	0	0	1	4.5	252	1,134	0	0	253	1,138
Dry Fork Cheyenne River		0		0		0		0	0	0
Upper Cheyenne River	0	0	0	0	433	1,948	21	94.5	454	2,043
Lightening Creek		0		0		0		0	0	0
Upper Belle Fourche River	0	0	509	2,290	4,114	18,513	39	175.5	4,662	20,979
Middle North Platte River	0	0	0	0	6	27	0	0	6	27
Total	517	2,327	1,165	5,243	10,097	45,437	298	1,341	12,077	54,346

Note: Disturbance is based on 4.5 acres per well, and includes disturbances associated with ancillary facilities.
Source: BLM 2001

very low to very high. TBNG lands within the Project Area have been inventoried with two scenic integrity levels. The scenic integrity level of Low refers to landscapes where the valued landscape character appears moderately altered. Most of the TBNG lands in the Project area are managed with the scenic integrity level of Low, as the grassland landscape appears moderately altered by oil, gas, and mineral development, and to a lesser extent, some grazing improvements such as fences. The scenic integrity level of Moderate refers to landscapes where the valued landscape character appears slightly altered. A portion of TBNG lands along Antelope Creek and TBNG lands in east of state Highway 59 in Converse County are assigned a scenic integrity level of Moderate.

Visual management objectives for SIOs are associated with desired landscape character for each management area, and are based on the intent of the management area direction. The desired condition for landscapes in each of the seven management areas within the Project Area is summarized in Table 3–57.

Table 3–57 Desired Conditions for TBNG Management Areas in the Project Area

Management Area		Desired Condition for Scenic Values
3.63	Black-Footed Ferret Reintroduction Habitat	na[1]
3.65	Rangelands with Diverse Natural-Appearing Landscapes	Natural appearing landscapes predominate; however, oil and gas facilities may occur and are subordinate to the landscape
3.68	Big Game Range	na
4.32	Dispersed Recreation: High Use	Appears as a natural-appearing landscape over large areas, but modifications on a small scale are acceptable and blend with the area's natural features.
5.12	General Forest and Rangelands: Range Vegetation Emphasis	These areas are dominated by open meadows, grasslands, shrublands and areas of woody vegetation. Signs of motorized travel, hunting, hiking, timber harvest, mining and grazing may be evident.
6.1	Rangeland with Broad Resource Emphasis	na
8.4	Mineral Production and Development	Facilities and landscape modifications are visible but are reasonably mitigated to blend and harmonize with natural features. Reclamation activities restore the area to a reasonable level of its pre-mining condition.

Note:
1. na = not applicable.

Counties

The Sheridan County Growth Management Plan (Sheridan Plan), a comprehensive master plan for the city of Sheridan and all of Sheridan County, was prepared in May of 2001. One of the primary themes identified in the Sheridan Plan is to maintain a community character that preserves the quality of life, values and traditions of the area. The goals and the associated implementation strategies that relate to mineral development for achieving this theme are described below.

Goal D. Maintain Natural and Historic Resources and Environmental Quality

1.D.1 Sheridan County should complete a comprehensive countywide inventory, from existing resources, of environmental, scenic, and historical resources and wildlife habitat. Data should be mapped using a Geographic Information System (GIS). This data should be utilized in the review and evaluation of proposed subdivisions as well as all commercial and industrial development. In the event that resources are impacted by a proposed development, the site would either not be developed or mitigation would be required. Resources to be inventoried should include, but are not limited to:

- Natural or scenic resource areas;
- Land reserved as open space or buffer areas as part of development;
- Linear open space, such as utility and trail corridors;
- Coal bed methane resources areas

The City of Gillette and Campbell County have jointly prepared a Comprehensive Planning Program (Program), last updated March 1994. The Program identifies parks and recreation planning, including landscaping and beautification, as an essential element determining the character and quality of an environment. The Program recommendation is that where industrial areas are located adjacent to residential areas, landscaping should be developed into the buffer zone between two uses.

The General Land Use Plan for Converse County (Converse Plan) was developed in August of 1978. The Converse Plan does not identify any objectives or policies for scenic resources or landscape character in the county. Converse County is currently updating the Land Use Plan.

Johnson County currently does not have a countywide zoning districts, land use districts, or a comprehensive land use plan, although they are in the process of developing one (Yingling 2001). The Buffalo/Johnson Joint Land Use Plan was adopted August 2001, and is currently under revision. This plan primarily addresses land uses adjacent to the residential areas within less than 10 miles from Buffalo. There are currently no goals for the management of scenic resources in the county.

Sensitive Viewing Areas

The level of sensitivity to modifications of the landscape in the Project Area ranges from low to high. Most of the Project area is not visually sensitive due to its remoteness from viewpoints used by the public. The overall population density of the rural portion of the Project Area is low. Visitor use of most public lands in the Project Area is light for recreation or other activities. The portions of the Project Area that have a high level of sensitivity to modification to the landscape occur in the vicinity of communities, along highway corridors, and at recreation-use areas. There are a significant number of residents and visitors exposed to these landscapes who would have a concern for scenic quality, and who would be sensitive to modifications to the landscape. In general, residents and other users of the area are accustomed to viewing existing mineral resource development, but could be sensitive to increased levels of development.

The majority of sensitive areas occur in the western part of the Project Area, including Interstate 25, the cities of Sheridan and Buffalo, and several recreation and historic sites. The Interstate 25 highway corridor, which connects several communities within the Project Area, has the highest levels of traffic of any highway in the Project Area. Recreational use areas are described in the following section on Recreational Resources. Sensitive areas in the remainder of the Project Area include Gillette and recreational use areas in the eastern part of the Project Area. Other travel routes include Interstate 90, several state highways, and numerous county roads and BLM roads that access the area from the highways. Public use of BLM roads is relatively low with motorists falling into the categories of local ranchers and residents, coal mine and gas field personnel, and recreationists.

Recreational Resources

Regional Characterization

The proposed Project Area consists of BLM, Forest Service, state and private lands in four counties in northern Wyoming. A significant portion of each county in the Project Area is public land. Public lands provide open space for a variety of dispersed outdoor recreation opportunities, as well as developed facilities to help meet the demand for site-oriented recreation. Recreation opportunities offered by the private sector consist of community facilities in urban areas and the infrastructure of tourist services and facilities.

The Project Area counties offer broad, panoramic prairie landscapes, which provide a setting for a variety of outdoor recreational activities. Major attractions include the Thunder Basin National Grassland, several State Historic Sites, and the historic Bozeman Trail. Most areas that provide recreational activities occur in the western portion of the Project Area, near the foothills of the Bighorn Mountains, and in the Powder River Breaks.

Recreational Use

Recreational use of the Project Area is limited, as more than 75 percent of the land is privately owned. Opportunities for dispersed recreation exist on federal and state lands throughout the Project Area. There are few developed recreational sites or facilities within special management areas on federal lands in the Project Area. Developed recreational facilities such as campgrounds are generally limited to private lands in or near to larger communities in the Project Area, and to state historical sites located in the western part of the Project Area. Communities in the Project Area, including Sheridan, Gillette, Wright, Buffalo, and Kaycee, provide a variety of municipal and private recreational facilities, including golf courses, rodeo grounds, ball parks, and swimming pools.

Dispersed Recreation

Dispersed recreational opportunities in the Project Area include hunting, fishing, sightseeing, off-road vehicle (ORV) use, and camping. Hunting is a major recreation use of state and federal lands in the Project Area. Various big game and upland game bird species are hunted in the region. Big game species include deer, elk, and pronghorn. Game birds hunted in the Project Area include wild turkey, sage grouse, sharp-tailed grouse, Hungarian partridge, chukar partridge, and ring-necked pheasant.

Public lands managed by BLM's Buffalo and Casper Field Offices provide diverse opportunities for recreation, including hunting, fishing, off-road vehicle (ORV) use, sightseeing, and wildlife observation. Public lands generally provide dispersed recreational uses in the Project Area. Some developed recreational facilities occur in special management areas, including Recreation Areas. Public lands support about three percent of the recreational use in the Buffalo Field Office area. While opportunities are available on BLM lands throughout the Project Area, the majority of dispersed recreational uses occur in the western part of the Project Area, including the South Big Horns Area, and along the Powder River. Public lands in much of the Project Area consists of small, isolated tracts of land managed by the BLM that are too small to provide a quality recreational experience. Larger parcels of public lands occur in the southwest part of Johnson County, and along the Powder River. Public lands are accessible via public roads and/or across private land that requires landowner permission.

Recreational use of public lands in the Project Area has increased substantially over the past two decades, and is expected to continue to increase by about five percent every five years for most recreational activities. Visitation to BLM and non-BLM lands in the Buffalo Field Office area, which includes most of the Project Area, is summarized in Table 3–58. Total visitor use by residents and nonresident visitors in 1980 was 730,000 visitor days. The total visitor days of 1,881,763 estimated for 1990 was more than quadruple the 1980 visitor days.

Table 3–58 Recreation Visitor Days in the Buffalo Field Office Area for 1990

	Resident Visitors			Nonresident Visitors			Total Visitor Days		
Type of Visitor Use	Non BLM	BLM	Total	Non BLM	BLM	Total	Non BLM	BLM	Total
Consumptive									
Antelope	4,503	261	4,764	12,263	837	13,100	16,766	1,098	17,864
Deer	49,195	3,042	52,237	39,980	3,861	43,841	89,175	6,903	96,078
Elk	102,421	2,139	104,560	12,449	272	12,721	114,870	2,411	117,281
Small Game	8,000	200	8,200	400	100	500	8,400	300	8,700
Fishing	300,000	3,000	303,000	75,000	1,000	76,000	375,000	4,000	379,000
Total	464,119	8,642	472,761	140,092	6,070	146,162	604,211	14,712	618,923
Nonconsumptive	578,000	15,440	593,440	652,000	17,400	669,400	1,230,00	32,840	1,262,840
Total Visitor Use	1,042,119	24,082	1,066,201	792,092	23,470	815,562	1,834,211	47,552	1,881,763

Source: BLM 2001

The WGFD manages big game populations in big game management units. The Project Area contains all or part of 18 antelope game units, 22 deer (white-tail and mule) game units, and 9 elk game units. The majority of hunting that occurs in antelope and deer hunting units is non-resident hunting. Table 3–59 summarizes the number of participating hunters, total hunter days, and non-resident hunters for big game management units in the Project Area.

Table 3–59 Big Game Hunting in the Powder River Basin Project Area, 2000

Game Unit	Active Hunters	Total Harvest	Hunter Success	Hunter Days	Non-Resident Hunters	Percent Non-Resident Hunters
Antelope	6,877	6,168	89.7%	19,128	5,272	76.7%
Deer	14,680	8,936	60.9%	49,811	7,781	53.0%
Elk	5,934	1,688	28.4%	39,328	981	16.5%

Source: WGFD 2001

Fishing is a popular year-round activity with residents of the Project Area. Bodies of water that are fished within the Project Area are summarized in Table 3–60.

Table 3–60 Fishing Areas in the Powder River Basin Project Area

Sub-Watershed	Water Body	Fish species
Middle Fork Powder River	Beartrap Creek	Brook, Rainbow
	Blue Creek	Brown, Brook, Rainbow
	Dull Knife Reservoir	Brown, Rainbow
	Powder River, Middle Fork	Brown
	Powder River, North Fork	Brown, Rainbow
Crazy Woman	Crazy Woman Creek	Brown, Brook, Rainbow
	Doyle Creek	Brown, Brook
Clear Creek	Clear Creek	Brown, Rainbow
	Lake de Smet	Brown, Rainbow
	North Piney Creek	Brook, Rainbow
Upper Belle Fourche	Gillette Lake	Rainbow

Source: WGFD 2000

Developed Recreation Areas and Recreation Use Sites

Project Area counties include several special recreation management areas on public and private lands. Recreation sites on public lands within each sub-watershed are summarized in Table 3–61. Connor Battlefield State Historic Site and Trail End State Historic Site are in western Sheridan County, near the city of Sheridan. Fort Phil Kearney state Historic Site is in west Johnson County between the cities of Sheridan and Buffalo. Recreational activities available in the Connor Battlefield site include camping and fishing. The Trail End and Fort Phil Kearney sites feature museums and tours. Limited developed recreation facilities are also located in special management areas on BLM-administered public lands.

Visits to the Historic Sites in the years between 1994 and 1998 are characterized by annual increases and decreases, as shown in Table 3–62. These fluctuations are not related to population changes in the counties, which have steadily increased, with the exception on Sheridan County (see Socioeconomic Section). Declines in visits to the parks probably result from ongoing renovation and construction.

There are two scenic byways in the western part of the Project Area that provide access to the Bighorn Mountains. The Bighorn Scenic Byway is on U.S. Route

14 west of Ranchester. The Cloud Peak Skyway is on U.S Route 16 west of Buffalo.

Table 3–61 Recreational Sites in the Powder River Basin Sub-watersheds

Sub-Watershed	Recreation Site	Managing Agency
Little Bighorn River	none	
Upper Tongue River	Amsden Creek Winter Game Refuge	Wyoming Game and Fish Dept.
	Connor Battlefield	Wyoming State Parks and Historical Resources
	Trail End State Historical Site	Wyoming State Parks and Historical Resources
	Cloud Peak Skyway (Wyoming State Scenic Byway)	Wyoming Department of Transportation
	Bozeman Trail	na[1]
Middle Fork Powder River	Middle Fork Recreation Area	BLM – Buffalo Field Office
	Ed O. Taylor Wildlife Habitat Management Area	BLM – Buffalo Field Office
	Gardner Wilderness Study Area	BLM – Buffalo Field Office
	North Fork Wilderness Study Area	BLM – Buffalo Field Office
	Outlaw Cave Recreation Site	BLM – Buffalo Field Office
	Dull Knife Battlefield	Wyoming State Parks and Historical Resources
	Bozeman Trail	na
North Fork Powder River	na	
Upper Powder River	Fortification Creek SMA and WSA	BLM – Buffalo Field Office
	Cantonment Reno	BLM – Buffalo Field Office
	Bozeman Trail	na
South Fork Powder River	na	
Salt Creek	Bozeman Trail	na
Crazy Woman Creek	Dry Creek Petrified Tree Environmental Education Area	BLM – Buffalo Field Office
	Bozeman Trail	na
Clear Creek	Bud Love Wildlife Habitat Management Area	Wyoming Game and Fish Dept.
	Ft. Phil Kearny State Historical Site	Wyoming State Parks and Historical Resources
	Mosier Gulch Recreation Area	BLM – Buffalo Field Office
	Big Horn Scenic Byway (Wyoming State Scenic Byway)	Wyoming Department of Transportation
	Bozeman Trail	na
Middle Powder River	na	
Little Powder River	Weston Hills Recreation Area	BLM – Buffalo Field Office
Little Missouri River	na	
Antelope Creek	Bozeman Trail	na
Dry Fork Cheyenne River	Bozeman Trail	na
Upper Cheyenne River	na	
Lightening Creek	na	
Upper Belle Fourche River	na	
Middle N. Platte Casper	Bozeman Trail	na

Note:
1. na = not applicable
Source: BLM 1984, 2001; National Scenic Byways Program 2001; WDSP&HS 2001

BLM

Several developed recreational sites and areas occur on BLM lands administered by the Buffalo Field Office, as summarized on Table 3–61. There were no developed recreation sites identified on BLM lands administered by the Casper Field Office within the Project Area. The South Big Horns Area is located in the southwest quarter of Johnson County, primarily within the Middle Fork Powder River sub-watershed. The area provides sensitive and unique resource values, including fisheries, cultural, wildlife, wilderness, and scenery. Special management areas that provide recreational opportunities within the South Big Horns Area include Middle Fork Recreation Area, the Red Wall/Hole-in-the-Wall area, Outlaw Cave Recreation Site (or Cultural Area), Dull Knife Battlefield site, and the Gardner Mountain and North Fork WSAs.

Table 3–62 State Historic Site Visitors: 1994–1998

Historic Site	1994	1995	1996	1997	1998
Connor Battlefield	23,694	18,592	18,926	18,670	15,379
Fort Phil Kearney	27,068	25,167	23,136	22,657	22,128
Trail End	16,584	12,247	16,828	18,004	19,377

Source: Wyoming Division of Economic Analysis 1999

The Middle Fork Recreation Area covers approximately 48,400 acres within the South Big Horns Area along the Middle Fork of the Powder River. The area contains a variety of outstanding natural resources, and is protected from mineral entry because it has unique visual qualities, wildlife habitat, fisheries, and general outdoor recreational qualities. The state of Wyoming has rated the Middle Fork of the Powder River as a Class I trout fishery that is of national importance. The Outlaw Cave Recreation Site, located along the Middle Fork of the Powder River in the Middle Fork Recreation Area, is an important historical site that provides camping, fishing, hiking, and other dispersed recreational activities.

The Dry Creek Petrified Tree Environmental Education Area, located near the town of Buffalo, has been designated as an outstanding natural area. The area contains a parking road, picnic table, and interpretive facilities.

Three WSAs provide primitive, undeveloped types of recreation. There is no public access to the North Fork and Fortification Creek WSAs. Public access to Gardner Mountain WSA is difficult because of the scattered land ownership.

There are two Recreation Areas on BLM-administered public lands in the Project Area. The Mosier Gulch Recreation Area (RA), is west of Buffalo on U.S. Highway 16. The RA includes a picnic area. The RA provides off-highway vehicle use of designated roads and a loop trail open to foot, horse, mountain bike, and ATV use. Two additional loop trails that also will provide these uses may be constructed in the RA. The Weston Hills RA is located in the eastern part of the Project Area, adjacent to a portion of the TBNG. The RA provides hunting and dispersed camping recreational opportunities. A two-mile ATV trail is open October 16 through September 14.

The Bozeman Trail is a historic transportation corridor that was used by historic Indian tribes, trappers and traders, exploration expeditions, American emigrants, the military, and settlers. There are several historical sites associated with the Bozeman Trail that provide recreational opportunities. Interpretive programs and historic sites along the trail include Fort Phil Kearny, Cantonment Reno, and the Connor Battlefield. The trail originates near Fort Laramie, south of the Project

Area, and runs through public and private lands along the eastern side of the Big Horn Mountains through the Project Area into Montana.

Approximately 798,848 acres of public land in Johnson, Sheridan, and Campbell counties has been inventoried and designated as open, limited, or closed to ORV use. Most ORV use in the counties is limited to existing roads and vehicle routes.

Forest Service

The TBNG provides a variety of wildland recreational opportunities to local residents, including many who are employed in mineral industries. Nearly all of the TBNG is open to use by ORVs. The area provides hunting opportunities for residents and non-residents, primarily big game species such as antelope and deer. Shooting restrictions have recently been implemented on the TBNG for the purpose of protecting special biological community associated with the future reintroduction of the endangered black-footed ferret.

Recreation Planning

BLM

The goals of recreation management for all BLM lands in the Project Area are to provide outdoor recreational opportunities on BLM-administered public land while providing for resource protection, visitor services, and the health and safety of public land visitors.

The BLM has also developed a management objective for special management areas within the Project Area, including the South Big Horns Area, the Dry Creek Petrified Tree Environmental Education Area, the Fortification Creek Area, the Weston Hill Recreation Area, and the Mosier Gulch Recreation Area. The management objective for recreation in these areas is to ensure continued public use and enjoyment of recreation activities while protecting and enhancing natural and cultural values; improve opportunities for high quality outdoor recreation; and, improve visitor services related to safety, information, interpretation, and facility development and maintenance.

In order to protect the sensitive and unique resource values of the South Big Horns Area, surface disturbance or occupancy is prohibited in the Red Wall/Hole-in-the-Wall area and within ½-mile of the rim of the Middle Fork Canyon. Goals for the two WSAs in the Area include preserving the existing wilderness characteristics of the WSAs and not allowing activity that would impair the suitability of the WSAs for preservation as wilderness.

Management decisions for the Dry Creek Petrified Tree Environmental Education Area are to preserve the area near its natural state, prevent or slow down deterioration of the petrified trees, and inform the visitor about the area. Surface disturbance or occupancy is prohibited within ½-mile of the site unless waived by the authorized officer.

Management objectives specific to the Fortification Creek Area, which includes the Fortification Creek WSA, are to allow orderly development of mineral resources while protecting wildlife habitat and sub-watershed areas, and maintaining wilderness values. No Surface Occupancy is allowed in elk calving areas, and a seasonal timing limitation is applied to elk wintering areas.

Public lands managed by the Casper Field Office are in three Resource Management Units; (RMU) 6, 11, and 14. The RMUs are within the Middle North Platte River, Dry Fork Cheyenne, and Lightning Creek sub-watersheds. There are no developed recreation sites on public lands administered by the Casper Field Office in the Project Area. Recreational activities consist of dispersed activities such as hunting and ORV use. Recreation management for each RMU is described below:

- RMU 6 (Casper Sand Dunes) – The RMU is managed as an extensive recreation management unit where dispersed recreation would be encouraged in areas where soil and sub-watershed values permit. ORV designations would limit travel to designated roads and vehicle routes on public land, except during the fall hunting season, when travel would be permitted on existing roads and vehicle routes. Recreation management is minimal, with emphasis on monitoring, use supervision, and enforcement to resolve user conflicts and provide resource protection.
- RMU 11 (Ross) – The RMU is managed as an extensive recreation management unit where dispersed recreation would be encouraged and where visitors would have freedom of recreational choice with minimal regulatory constraint. ORV use is limited to existing roads and vehicle routes on all public lands within the unit.
- RMU 14 (Remaining Platte River Resource Area) – RMU 14 comprises all lands managed by the Casper Field Office not included in the other RMUs, and contains portions of the Thunder Basin National Grassland. It is managed as an extensive recreation management unit where dispersed recreation would be encouraged and where visitors would have freedom of recreational choice with minimal regulatory constraint. ORV use is limited to existing roads and vehicle routes for those Project Area on all public lands within the unit.

Forest Service – Thunder Basin National Grassland

The Medicine Bow-Routt National Forest has developed a Proposed LRMP for the TBNG (1999). Under the Preferred Alternative 3, TBNG lands within the Project Area are within seven management areas. Each management area is managed for a particular emphasis or theme. The standards and guidelines for recreation in each management area is summarized in Table 3–63.

National Forest System lands are inventoried and mapped by Recreation Opportunity Spectrum (ROS) class to identify the opportunities for recreation activities that occur on National Forest System lands. The ROS system is a continuum divided into six classes ranging from Primitive to Urban. All of the TBMG lands in the Project Area have been inventoried with the Semi-Primitive Motorized class (Forest Service 1986).

Table 3–63 Recreation Standards and Guidelines for TBNG Management Areas in the Project Area

Management Area		Standards & Guidelines
3.63	Black-Footed Ferret Reintroduction Habitat	-Prohibit shooting in prairie dog colonies unless needed to help reduce unwanted colonization of adjoining lands. (Guideline) -Work with Animal and Plant Health Inspection Service and state agencies to prohibit the use of leg-hold traps without pan-tension devices for predator control and fur harvest on National Forest System lands in this management area. (Guideline)
3.65	Rangelands with Diverse Natural-Appearing Landscapes	na
3.68	Big Game Range	Permit recreation facilities needed to support summer recreational activities, but close them during period when big game are present in concentrated numbers. (Guideline)
4.32	Dispersed Recreation: High Use	-Allow uses and activities (e.g., grazing, mineral leasing) only if they do not degrade the characteristics for which the area was identified. (Guideline) -Do not salt or supplement feed within ¼-mile of designated roads. (Guideline)
5.12	General Forest and Rangelands: Range Vegetation Emphasis	na
6.1	Rangeland with Broad Resource Emphasis	na
8.4	Mineral Production and Development	na

The Semi-Primitive Motorized class is characterized by a predominantly unmodified natural environment in a location that provides good to moderate isolation from sights and sounds of man except for facilities and travel routes sufficient to support motorized recreational travel opportunities that present at least moderate challenge, risk, and a high degree of skill testing.

State

The mission of Wyoming State Parks and Historic Sites is to provide quality recreational and cultural land and opportunities, and to be responsible stewards of these resources. The Wyoming Department of State Parks & Cultural Resources has the authority to promulgate rules and regulations governing state parks. These rules include and cover the following areas: (a) Conservation of peace and good order within each park; (b) Preservation of state property; and (c) Promotion of well being for park visitors and residents. There is no provision in the rules and regulations governing the development of mineral or other industrial developments within state parks.

Counties

The Sheridan County Growth Management Plan (Sheridan Plan), a comprehensive master plan for the city of Sheridan and all of Sheridan County was prepared in May of 2001. One of the primary themes identified in the Sheridan Plan is to maintain a community character that preserves the quality of life, values and traditions of the area. The goals and the associated implementation strategies that relate to mineral development for achieving this theme are described below.

Goal E. Enhance Recreational Opportunities

1.E.1 Protect open spaces, flood channels, and waterways throughout Sheridan County by planning for an integrated open space network compatible with existing trails or pathway plans, open space plans, or flood management plans. As subdivisions and other development are reviewed, achieve over time a comprehensive open space network.

1.E.2 As part of subdivision review, encourage the development of the Sheridan Pathways project and the development of a trail along Little Goose Creek.

1.E.3 Encourage recreation activities in Sheridan County.

1.E.5 Support efforts to identify and obtain open space in the county. The Sheridan County Planner should investigate and pursue mechanisms that can enable open space to be preserved. Open space, to be meaningful and usable, should be lands that:

- Are adjacent to existing open space or public lands;
- Have special scenic or environmental qualities;
- Enable the preservation of scenic, recreational, or environmental resources, and;
- Include pathways, bikeways, trails, golf courses, recreational areas, parks, historic areas, and conservation easements. With the long-term goal of eventual connection of various units of open space acquired through the subdivision process, an open space network can be created.

The City of Gillette and Campbell County have jointly prepared a Comprehensive Planning Program (Program), last updated March 1994. The Program identifies parks and recreation planning as an essential element determining the character and quality of an environment. Existing parks and their facilities that are maintained by the Campbell County Parks and Recreation Department are listed in the Program document. Existing facilities are located primarily within or in the vicinity of the cities of Gillette and Wright. The Savageton Community Park is located ¼-mile south of Savageton in southwestern Campbell County.

The General Land Use Plan for Converse County (Converse Plan) was developed in August of 1978. According to the Converse Plan, Objective #3 for Rural Centers is to provide for those recreational activities as required by the increase of population. The policy to achieve this objective is to have recreational developments only in those areas with adequate access and in conformance with the Land Use Plan and Converse County Subdivision and Development Regulations. Converse County is currently updating the Land Use Plan.

Johnson County is currently developing a land use plan. There are no goals for the management of recreation resources in the county.

Wild and Scenic Rivers

The BLM has identified public lands along four waterway segments that were determined to meet the eligibility criteria for Wild and Scenic River (WSR) designation. The waterway review segments that were evaluated for eligibility criteria are along the Beartrap Creek, the Middle Fork of the Powder River, the Powder River at Cantonment Reno, and the North Fork of the Powder River review segments. The Beartrap Creek, North Fork of the Powder River, and the Powder River at Cantonment Reno were found to be not suitable for Wild and Scenic Rivers status primarily because of private land use and public access conflicts, or because they would not be worthy additions to the system. The Middle Fork of the Powder River was determined to be a worthy addition to the Wild and Scenic River System. The eligibility analyses for the four waterway review segments are included in the attachments A, B, and C of BLM's Approved Resource Management Plan for the BFO (2001). The analysis for the Middle Fork of the Powder River is summarized on Table 3–64.

Table 3–64 Middle Fork of the Powder River Waterway Segments Eligible for WSR Designation in the Powder River Project Area

Reviewed Waterway Segment	Length of segment across BLM Land Parcel	Outstandingly Remarkable Values	Tentative Classification
sec. 25, 26; T42N, R86W	1.2	Fisheries; Class 1 fishery	Recreational
W½ NW¼ sec. 30; T42N, R85W	0.25	Fisheries; Class 1 fishery	Wild
sec. 19-23, 28-30; T42N, R85W	3.25	Scenic, Fisheries, Cultural, Wildlife, Recreational; Class 1 fishery. Native American cultural sites. Recreational hiking and cultural interpretation opportunities.	Wild
sec. 22, 23; T42N, R85W	1.0	Scenic, Fisheries, Cultural, Wildlife, Recreational. Class 1 fishery. Native American cultural sites. Recreational hiking and cultural interpretation opportunities.	Wild
sec. 19-22, 30; T42N, R84W and sec. 24; T42N, R85W	5.0	Scenic, Fisheries, Wildlife, Recreational, Historic, Cultural; Spectacular, primitive canyon. Nationally and regionally historic Outlaw Cave. Native American rock art and shelter sites. Class 1 fishery. Recreational hiking and cultural interpretation opportunities.	Wild

Source: BLM 2001

Noise

Noise is generally described as unwanted sound. Discussions of environmental noise do not focus on pure tones because commonly heard sounds have complex frequency and pressure characteristics. Accordingly, sound measurement equipment has been designed to account for the sensitivity of human hearing to different frequencies. Correction factors for adjusting actual sound pressure levels to correspond with human hearing have been determined experimentally. For measuring noise in ordinary environments, A-Weighted correction factors are employed. The filter de-emphasizes the very low and very high frequencies of sound in a manner similar to the response of the human ear. Therefore, the A-weighted decibel (dBA) is a good correlation to a human's subjective reaction to noise.

The following discussion sets a basis of familiarity with known and common noise levels. A quiet whisper at five feet is 20 dBA; a residential area at night is 40 dBA; a residential area during the day is 50 dBA; a large and busy department store is 60 dBA; rush hour traffic at 100 feet from the road is 60-65 dBA; Interstate traffic at 200 feet is 65 dBA; a heavy truck at 50 feet is 75 dBA; and a typical construction site is 80 dBA. At the upper end of the noise spectrum, a jet takeoff at 200 feet is 120 dBA (Harris 1991).

The dBA measurement is on a logarithmic scale. The apparent increase in "loudness" doubles for every 10 dBA increase in noise (Bell 1982). Taking a baseline noise level of 50 dBA in a daytime residential area, noise of 60 dBA would be twice as loud, 70 dBA would be four times as loud, and 80 dBA would be eight times as loud.

The land uses in the Project Area range from sparsely populated rural regions to more densely populated urbanized areas to industrial areas, such as coal mining and CBM operations. Major sources of noise are towns; industrial facilities; major roadways, such as Interstate 90; railroad corridors; and frequent high winds. Background noise surveys have not been conducted in the area. However, noise in rural areas away from industrial facilities and transportation corridors is generally 30 to 40 dBA when the winds speeds are low. Levels of noise close to industrial facilities and transportation corridors are likely to be in the range of 50 to 70 dBA depending on the proximity to these sources. The most significant noise from CBM operations results from the operation of compressor stations that use multiple engines to move natural gas from central gathering facilities and along high-pressure transmission pipelines. Noise from these compressor stations has been estimated has been estimated to be 55 dBA at 600 feet from the compressor station (BLM 2000).

Socioeconomics

The Project Area encompasses all or portions of Converse, Campbell, Johnson, and Sheridan counties in Wyoming. It also includes four incorporated municipalities: Gillette, Wright, Sheridan, and Buffalo. Gillette is the county seat and the largest incorporated city in Campbell County. Wright is in southern Campbell County. Sheridan is the county seat of Sheridan County and Buffalo is the county seat of Johnson County. These four counties are the primary counties that potentially would experience socioeconomic impacts. However, socioeconomics, with respect to Environmental Justice, will also be addressed herein for four Counties in Montana, just north of the Project Area.

Population

The 2000 population in the Project Area is: Converse County, estimated at 12,052; Campbell County, estimated at 33,698; Johnson County, estimated at 7,075; and Sheridan County, estimated at 26,560. The total population is 79,385 for these four counties combined, which make up 16 percent of the population in State of Wyoming. Table 3–65 summarizes population growth and projections of population growth between 1980 and 2002.

Table 3–65 Population Estimates in Campbell, Converse, Johnson, Sheridan Counties and Wyoming

Location	1980	1990	1996	1997	2000
Campbell County	24,367	29,370	31,931	32,071	33,698
Gillette	14,545	17,545	21,585	19,289	19,646
Wright	Na	1,117	1,385	1,347	1,347
Converse County	14,069	11,128	12,125	12,295	12,052
Douglas	Na	5,076	5530	5,634	5,288
Glenrock	Na	2,153	2329	2,367	2,231
Johnson County	6,700	6,145	6,717	6,796	7,075
Buffalo	Na	3,302	na	na	3,900
Kaycee	Na	260	303	308	307
Sheridan County	25,048	23,562	25,203	25,199	26,560
Sheridan	Na	13,900	na	na	15,804
State of Wyoming	469,551	453,588	480,085	480,031	493,782

Source: U.S. Census Bureau 1998a, Wyoming Division of Economic Analysis 1997a.

Growth in these counties has also been prevalent over the last ten years. According to the U.S. Census Bureau, the Counties within the Project Area have undergone 12.7 percent growth between 1990 and 2000. Johnson County had a 15.1 percent growth in that time period, ahead of Campbell (14.7 percent), Sheridan (12.7 percent) and Converse (8.3 percent) Counties.

Between 2000 and 2008, it is projected that the counties within the Project Area will experience the following population increases: Campbell County will increase by 4 percent; Converse County will increase by 8 percent; Johnson County will increase by 4 percent; and Sheridan County will decrease by 0.5 percent. All counties within the Project Area, with the exception of Sheridan County, will have higher population increases than the projected population increase for the State of Wyoming of 2 percent. Projected population within the Project Area is provided in Table 3–66.

Table 3–66 Projected Populations in Campbell, Converse, Johnson, Sheridan Counties and Wyoming

Location	2001	2002	2003	2004	2005	2006	2007	2008
Campbell County	33,210	33,490	33,780	34,080	34,370	34,670	34,970	35,270
Gillette	19,970	20,075	20,249	20,429	20,603	20,783	20,962	21,142
Wright	1,384	1,396	1,408	1,420	1,432	1,445	1,457	1,470
Converse County	12,550	12,640	12,720	12,810	12,900	12,990	13,080	13,170
Douglas	5,725	5,766	5,803	5,844	5,885	5,926	5,967	6,008
Glenrock	24,00	2,428	2,444	2,461	2,478	2,496	2,513	2,530
Johnson County	6,970	7,030	7,090	7,150	7,210	7,270	7,330	7,390
Buffalo	3,741	3,773	3,806	3,838	3,870	3,902	3,934	3,967
Sheridan County	25,480	25,600	25,740	25,870	26,010	26,140	26,270	26,410
Sheridan	14,864	14,934	15,016	15,092	15,173	15,249	15,325	15,407
State of Wyoming	486,240	488,480	490,810	493,230	495,630	498,020	500,380	502,780

Source: Wyoming Division of Economic Analysis 1997a.

Employment

The annual average labor force for the Project Area consists of 37,337 employees and the overall unemployment rate for the Project Area is 6.7 percent, 0.4 percent higher than the unemployment rate for the State of Wyoming. Specific labor force estimates, by County and for the State of Wyoming, are provided in Table 3–67.

Table 3–67 Labor Force Estimates

Location	Labor Force	Employment	Unemployment	Unemployment Rate (percent)
Campbell County	18,520	17,541	979	5.3
Converse County	6,508	6,105	403	6.2
Johnson County	3,750	3,579	171	4.6
Sheridan County	13,364	12,655	709	5.3
State of Wyoming	239,000	224,000	15,000	6.3

Source: Wyoming Department of Employment 1997a.

Employment Sectors and Wages

Wyoming Department of Employment (WDOE), Employment Resources Division, records describe the employment sectors in the affected Counties. The 1997 Campbell County employment statistics indicated that the primary employment sectors were dominated by Mining (consists of coal mining, oil and gas extraction, crude, petroleum-natural gas, oil and gas field service and nonmetalic minerals as defined by the US Bureau of Labor Statistics), Local Government, Tetail Trade and Services. Specifically, 25 percent of the income was from Mining, 17 percent was from Local Government, 17 percent was from Retail Trade, and 15 percent was from Services. Agriculture accounted for 1 percent of the employment in the County.

The 1997 Converse County employment statistics indicated that the primary employment sectors were dominated by Mining, Local Government, Retail Trade and Services. Specifically, 21 percent of the income was from Mining, 29 percent was from Local Government, 25 percent was from Retail Trade, and 15 percent was from Services. Agriculture accounted for 2 percent of the employment in the County.

The 1997 Johnson County employment statistics indicated that the primary employment sectors were dominated by Local Government, Retail Trade and Services. Specifically, 22 percent was from Local Government, 24 percent was from Retail Trade, 18 percent was from Services. Agriculture accounted for 2 percent of the employment in the County and, unlike Converse and Campbell Counties, area only 5 percent of the income was from Mining.

The 1997 Sheridan County employment statistics indicated that the primary employment sectors were dominated by Local Government, Retail Trade and Services. Specifically, 18 percent was from Local Government, 22 percent was from Retail Trade, and 25 percent was from Services. Agriculture accounted for less than 1 percent of the employment in the County and, unlike Converse and Campbell Counties, less than 1 percent of the income was from Mining.

Table 3–68 also identifies the Income and Earnings by industry for all four Counties. Mining consistently averages to be one of the highest paying industries, as does Finance, Insurance, Real and Estate (FIRE) and Transportation, Communication and Utilities (TCU). Employment in Agriculture and Retail Trade, tend to have the lowest earnings in all four Counties.

Table 3–68 Employment Income and Earnings by Industry

	Average Annual Wage				
Industry	Campbell County	Converse County	Johnson County	Sheridan County	State of Wyoming
Agriculture	13,976	14,625	18,882	14,886	16,161
Construction	27,655	27,957	17,730	20,738	25,509
Finance, Insurance, Real Estate	22,704	20,414	24,284	33,695	28,954
Manufacturing	33,534	19,746	18,358	25,147	30,798
Mining	52,702	45,018	35,188	41,514	47,053
Public Administration	28,431	26, 172	26,600	30,252	27,863
Trade-Retail	13,447	10,234	10,703	12,196	12,884
Trade-Wholesale	35,988	12,995	17,480	25,704	29,133
Services & Misc.	20,276	14,047	15,511	18,197	18,712
Transportation, Communication & Utilities	30,884	48,433	24,527	25,547	32,283
Total (average)	30,420	24,682	18,517	20,920	26,935

Source: Wyoming Department of Employment, Employment Resources Division, 1997a and 1997b.

The median household income in Converse, Johnson and Sheridan counties increased between 1969 to 1997 by an average of 64 percent. The median household income in Campbell County decreased by 3 percent between 1969 and 1997. All four Counties experienced a peak in median household income in 1979. Campbell County median household incomes were higher than the State of Wyoming average, while Johnson and Sheridan Counties experienced lower median household income than the State of Wyoming average. Converse County also experienced higher median household income (Table 3–69) than the State of Wyoming, with the exception of 1969, when the average was slightly lower.

Table 3–69 Median Household Income

Location	1969	1979	1989	1997
Campbell County	34,103	43,668	37,055	33,197
Converse County	23,365	38,026	27,713	37,978
Johnson County	21,313	27,659	22,157	31,832
Sheridan County	20,699	30,348	24,772	33,000
State of Wyoming	25,288	33,503	27,096	33,197

Source: Wyoming Division of Economic Analysis 1997b and the US Census Bureau 2000b.

Housing

The property values within each community could potentially be impacted by an influx in population. Currently, home values within the Project Area range from $76,000 to $130,000 for an existing three bedroom and $120,000 to $160,000 for a new three bedroom (Table 3–70).

Table 3–70 Property Valuation

	Cost of Individual Homes in 2001	
Location	Average New Three Bedroom	Average Existing Three Bedroom
Campbell County		
Gillette	$132,560	$106,110
Wright	$120,000	$76,531
Converse County	$132,000	$106,111
Johnson County		
Buffalo	$160,000	$130,000
Sheridan County		
Sheridan	$107,000[a]	NA

Note:
a. 1999 data only, in 2001 the average cost of three bedroom in rural areas was 125,000.
Sources: Buffalo Chamber of Commerce 2001, Campbell County Chamber of Commerce 2001.

Housing costs within the Project Area vary considerably. Of all counties within the Project Area, Campbell County has experienced some of the higher cost for real estate. According to the Campbell County Board of Realtors, residential property in Gillette, 71 percent of homes sold during the 2Q 2000- 1Q 2001 were priced less than $120,000 (Campbell County 2001). In the same time period, 94 percent of residential properties in Wright priced at $100,000 or less. However, the greatest number of sales occurred in the $60,000- $70,000 range. No properties in this price range were sold following 2Q 2000.

The majority of the available housing in the Project Area a located in the communities of Gillette, Wright, Sheridan and Buffalo. There were a total of 35,037 housing units in the Project Area in 2000. In 1990, the average housing availability rate for the Project Area was 23.3 percent. Table 3–71 identifies the Housing Units and Availability for all four Counties.

According to the Campbell County Housing Needs Assessment, it is estimated that in 2001, 98 housing units will be rentals and 92 housing units will be purchased as a result of Coal Bed Methane Development and Production. It is also estimated that county wide, as a result of all industries, 449 housing units will be rentals and 861 housing units will be purchased housing. Current projections from this study indicated that rental demand associated with Coal Bed Methane continue to increase (249 rentals) through 2008, and will slowly decrease thereafter (study limited to 2020). Projected purchase demand will continue to increase (465 purchases) through 2009, and will slowly decrease thereafter (study limited to 2020).

Table 3–71 Housing Units and Availability

Location	Housing Units (count) in 2000	Housing Availability in 1990
Campbell County	13,288	15.8%
Gillette	7,31	
Wright	544	
Converse County	5,669	29.4%
Douglas	2,385	
Glenrock	1,131	
Johnson County	3,503	29.8%
Buffalo	1,842	
Sheridan County	12,577	18.3%
Sheridan	7,413	

Source: U.S. Census Bureau 1990 and 2000c.

Housing costs range from $353 per month, in Converse County to $432 per month, in Campbell County, for a 2-bedroom apartment. The average 2 to 3 bed-room house ranges from $436 per month, in Converse County, to $632 per month in Campbell County. In all housing categories and all counties, mobile homes tend to provide the most economical housing value. Overall, housing costs are highest in Campbell County and lowest in Converse County. Housing Costs are shown in Table 3–72.

Table 3–72 Monthly Housing Costs for the 4th Quarter of 2000

	Housing Cost by County per month			
Housing Cost (4qtr 2000):	Campbell	Converse	Johnson	Sheridan
2-bedroom Apartment	$432	$353	$396	$405
Single-wide mobile home w/ water	$197	$115	$137	$175
2/3 bedroom house	$632	$436	$569	$580
Monthly mobile home rent including lot rent	$483	$324	$488	$447

Source: Wyoming Division of Economic Analysis, 2000a.

Community and Government Services

Natural gas and CBM exploration and resource development activities have the potential to affect existing community facilities and infrastructure. The use of, or connection to existing infrastructure including impacts population, which subse-quently can affect local community services such as schools, law enforcement, or medical facilities. The following paragraphs present a baseline description of these facilities and services

Water and Wastewater Systems, and Solid Waste Disposal

Generally, each county relies on the municipal population centers to provide wa-ter, waste water systems, and solid waste disposal. In some instances, the coun-ties contribute financially to the municipal infrastructure. Communities, which are not incorporated into the city water and septic system, generally provide for themselves with water wells and septic tanks on their personal property. In

Campbell County, water, waste water systems and solid waste disposal are operated by the city of Gillette. In Converse County the water, waste water systems and solid waste disposal are operated by the communities of Glenrock and Douglas. Glenrock and Douglas each have their own landfill, which the county contributes to financially. In Johnson County the water, waste water systems and solid waste disposal is operated by the City of Buffalo. In Sheridan County the water, waste water systems and solid waste disposal by the City of Sheridan.

Public Schools, Law Enforcement and Fire Protection, Medical Facilities, Community Services

There are 78 Pre Kindergarten through 12th grade public schools in the Project Area. Campbell County operates 22 public schools, Converse County operates 14 public schools, Johnson County operates nine public schools, and Sheridan County operates 24 public schools. Sheridan College, Eastern Wyoming College in Glenrock and Douglas, and University of Wyoming extension services are higher education learning centers within the Project Area.

Law enforcement services within Campbell County are provided by the Campbell County Sheriff's Department. The department consists of 39 sworn officers and 22 patrol officers. Law enforcement services within Converse County are provided by the Converse County Sheriff's Department, which has 9 sworn officers. Law enforcement services within unincorporated Johnson County are provided by the Johnson County Sheriff's Department, which has 14 sworn officers. Kaycee and Buffalo (Johnson County) also have police departments, each with 1 and 13 sworn officers. Law enforcement services within unincorporated Sheridan County are provided by the Sheridan County Sheriff's Department, which has 15 sworn officers. The City of Sheridan Police Department also has 29 sworn officers.

Each County in the Project Area operates a detention center. The Campbell County Detention Facility has 101 beds, the Converse County Detention Facility has 34 beds, the Johnson County Detention Facility has 17 beds and the Sheridan County Detention Facility has 46 beds. According to personnel at the Sheridan County Detention Facility, the presence of CBM development has had a direct impact on the facility. The facility has increased in population in the last year by approximately one third, primarily due to DUI (Driving Under the Influence) arrests and secondarily due to public intoxication by CBM employees (Smith 2001).

Fire protection in Campbell County is provided by the Campbell County fire department, which consists of 13 full time fire fighters and 150 volunteer fire fighters. Fire protection in Converse County is provided by the Campbell County Rural Fire Department, Glenrock Fire Department and Douglas Fire Department, which consists of a total of 125 volunteer fire fighters. Fire protection in Johnson County is provided by the Johnson County Fire Department. Sheridan County has 24 full time fire fighters, employed by the City of Sheridan and aided through a mutual aid agreement, which involvers approximately 50 fire fighters in the surrounding communities of Ranchester, Dayton, Bighorn and Story.

There are six 24-hour emergency service hospitals within the Project Area. The Campbell County Memorial Hospital is a 119-bed community hospital. In Converse County, two hospitals operate, one in Douglas, which has 44 beds, and one in Glenrock. In Johnson County, the hospital has 29 beds. In Sheridan County, the Sheridan County Memorial Hospital has 80 beds. The Veterans Administration Hospital also serves Sheridan County. All the counties in the Project Area have ambulance service, additional medical facilities, and specialized physicians.

A number of social service resources exist within the Project Area, generally sponsored by the cities and counties. The Way Station (Gillette) and the Volunteers of America Homeless Center (City of Sheridan) are homeless shelters in the Project Area. In Johnson County, there are additional social services through the Family Crisis Center and Ministerial Association in Buffalo.

Public Finance

Wyoming is the top coal producing state in the United States. According to the Campbell County Chamber of Commerce more than 90 percent of the coal produced in the State of Wyoming comes from Campbell County (BLM 1999c). Campbell County also produces approximately 25 percent of oil produced in Wyoming each year. Table 3–73 shows the state assessed mineral production valuations for the affected Counties and the State for Wyoming for its 2000 fiscal year, which are based on 1999 production.

Table 3–73 Taxable Valuation of Mineral Production for Fiscal Year 1999 Campbell, Converse, Johnson, and Sheridan Counties

	Taxable Mineral Valuation						
Valuation Source	Coal	Crude and Stripper Oil	Natural Gas	Sand & Gravel	Uranium	Other Minerals[1]	Total Assessed Valuation
Wyoming Valuation ($ million)	1,246	908	1,624	10.9	19.4	275	4,083
Campbell County Valuation ($ million)	976	215	98.9	2.98	1.58	0	1,294
Percent of State's Valuation	79%	24%	6.0%	27%	8.1%	0	32%
Converse County Valuation ($ million)	74.8	64	39.3	0.557	0	.245	186
Percent of State's Valuation	6.0%	6.0%	2.4%	%	0	0.09%	4.6%
Johnson County Valuation ($ million)	0	20.8	1.35	0.808	0.095	0.969	23.4
Percent of State's Valuation	0	2.3%	0.08%	7.0%	0.50%	0.35%	0.56%
Sheridan County Valuation ($ million)	0.897	0.486	0.001	0.420	0	0	1.80
Percent of State's Valuation	0.07%	0.05%	0.001%	3.8%	0	0	0.044%

Note:
1. Includes Bentonite produced in Johnson County and Leonardite produced in Converse County.
Source: Wyoming Department of Revenue 2000

Agriculture, consisting of livestock production and dryland farming also is an important sector of the economic base within the affected Counties. According to Campbell County Economic Development Corporation, livestock population in the County consists primarily of cattle and sheep. Most cropland in Campbell County produces wheat, barley, oats, and hay for fed. Agriculture in Converse, Johnson, and Sheridan counties consists of ranching, crops such as wheat, barley and oats, and irrigated forage crops (BLM 1999c).

The taxable valuation of mineral production provides a significant amount of capital to the governing agencies. According to the Wyoming Department of Revenue, for the fiscal year 1999 through June 30, 2000, 37 percent of State of Wyoming's Taxable Valuation of Minerals Production was from the Project Area. Campbell County accounted for the highest taxable mineral valuation of the State of Wyoming for coal with in the Project Area (79 percent) and also was had the highest taxable mineral valuation of the State of Wyoming for crude and stripper oil (24 percent). Based on the existing tax structure for the State of Wyoming, mineral production creates a significant tax-generating stream. The taxes on production are provided in Table 3–74.

Table 3–74 State of Wyoming Oil and Gas Taxes

Tax	Rate
Severance Tax	6% on normal
Ad Valorem Taxes	6.3 percent (Campbell and Converse Counties in 1999) 6.8 percent (Johnson and Sheridan Counties in 1999)
Wyoming Oil and Gas Tax Variances	Tertiary Oil Production (4%) Renewed Production (1.5% severance tax for 1st 60 month production period); Workover/Recompletion Production (2 percent severance tax for 1st 24 months of production after Workover/Recompletion) New wells drilled (7/1/93-3/31/03) (2% severance tax for 1st 24 months of production up to 60 bbls/day or 6MCF/bbl gas equivalent)
Wyoming Oil and Gas Conservation Tax	0.060 percent
Tribal Severance Tax	8.5 percent on non-stripper oil production and gas production and 4 percent on oil stripper wells (bpd or less)

Source: BLM 2001c.

Quality of Life

Public lands within the Project Area also provide a variety of benefits to adjacent landowners and communities that are much more difficult to quantify than the socioeconomic indicators provided here. These benefits include contributions to a person's quality of life, like scenic view, open space, and opportunities for recreation, habitat for wildlife, range for agriculture, clean air and water. While oil and gas development certainly provides some economic opportunities for residents and communities, such as employment and tax revenues, such development is perceived by some as detracting from their quality of life. In most cases, this perception is shared by those not directly benefiting from the industry's activities.

Since quality of life is more a matter of personal perspective than a definitive outcome, which BLM can directly affect, BLM will not attempt to quantify quality of life issues nor prescribe a desired outcome. Rather the focus will be on more site-specific factors within the EIS, which might affect the quality of life, like wildlife, agriculture, recreation, air quality, water quality and scenic viewsheds.

Environmental Justice

On February 11, 1994, the President of the United States issued Executive Order 12898 on Environmental Justice in Minority and Low Income Populations. The purpose of the Order is to identify and address, as appropriate, disproportionately high and adverse human health and environmental effects of programs, policies, or activities on minority or low income populations. In the Project Area for this EIS, minority populations include Native American, Hispanic, and low-income Caucasian populations. Large segments of these populations also compose the low- income groups in this area.

Although the Project Area is within Wyoming, socioeconomic impacts, with respect to Environmental Justice, may be felt beyond the Project Area, specifically in four counties (Big Horn, Powder River, Rosebud and Yellowstone) in Montana, which are the home of two Indian Reservations (Crow and Northern Cheyenne). The majority of the Crow Reservation and approximately half of the Northern Cheyenne Indian Reservation are located within Big Horn County Montana. A very small portion of the Crow Indian reservation is located in Yellowstone County Montana and the remaining half of the Northern Cheyenne Indian Reservation occupies approximately one tenth of the Rosebud County Montana.

Because the socioeconomic affects may be felt in these adjacent communities, it is important to evaluate the social composite of these areas as well. Specifically, due to the proximity of the Crow and Northern Cheyenne Indian Reservations, an Environmental Justice analysis is incorporated in this EIS, as the project has the potential to impact these communities. The Crow Reservation is bordered on the south by the State of Wyoming with its northwestern boundary bordered by the city of Billings, Montana's largest metropolitan area. According to the Wyoming-Montana Tribal Leaders Council, approximately 76 percnet of the 9,024 enrolled members live on the Crow Reservation. The total labor force on the Crow Reservation is 1,546. The unemployment rate is 44 percent. The average per capita income is $4,243. Approximately 69.8 percent have a high school diploma and over 6 percent have a Bachelor's Degree or higher (Tribal Leaders Council 2001b).

The Northern Cheyenne Reservation covers 445,000 acres and is bounded on the east by the Tongue River and on the west by the Crow Reservation. The total tribal enrollment is 6,479. Approximately 4,064 Northern Cheyenne live on or near the reservation. The total labor force of the reservation is 1,218 and the unemployment rate is 31.4 percent. The per capita income is $4,479. Approximately 62 percent of the tribal members have a high school diploma and 5.6 percent have a Bachelor's Degree or higher (Tribal Leaders Council 2001b).

Racial Composite

The Racial Composite of four Counties in Wyoming (Campbell, Converse, Johnson and Sheridan) and four Counties in Montana (Big Horn, Powder River, Rosebud, and Yellowstone) are generally white. As shown in Table 3–75, Big Horn County and Rosebud County, which are occupied by both Indian Reservations, have much higher percentage of American Indians, (32 percent and 60 percent, respectively) than the State of Montana (6.2 percent).

Table 3–75 Racial Composite by County and State for 2000

	Portion of Racial Composite (percent)							
Location	White	Black	Amer. Indian, Eskimo, or Aleut	Asian	Native Hawaiian or Pacific Islander	Some Other Race	Two or More Races	Hispanic Origin
Campbell County	96.1	0.2	0.9	0.3	0.1	1.1	1.3	3.5
Converse County	94.7	0.1	0.9	0.3	0.0	2.5	1.5	5.5
Johnson County	97.0	0.1	0.6	0.1	0.0	0.6	1.6	2.1
Sheridan County	95.9	0.2	1.3	0.4	0.1	0.8	1.3	2.4
State of Wyoming	92.1	0.8	2.2	0.5	0.1	2.5	1.8	6.4
Big Horn County	36.6	0	60.0	0.2	0	0.7	2.8	3.7
Powder River County	97.4	0	1.8	0.1	0	0.2	0.5	0.6
Rosebud County	64.4	0.2	32.4	0.3	0	0.6	2.0	6.0
Yellowstone County	92.8	0.4	3.1	0.5	0.04	1.3	1.8	3.7
State of Montana	90.6	2.9	6.2	0.5	0.05	0.6	1.7	2.0

Source: US Census Bureau 2000c and Wyoming Divion of Economic Analysis 2000.

Population by Age

Population by Age indicates that generally the majority of the population affected by the Proposed Project is between the ages of 25 and 44 years of age. The percentage of the population within the Project Area is consistent of the percentage of the population in the State of Wyoming, with the exception of Power River County, which has 21.9 percent over the age of 65, compared with 13.1 percent for the State of Wyoming. Table 3–76 provides the percentage of the population by age.

Poverty

As shown in Table 3–77 the poverty rates in Converse, Johnson and Sheridan Counties, 12.6 percent, 13 percent and 12.5 percent respectively, are slightly higher than that for the State of Wyoming poverty rate of 12 percent. Campbell County, which has a poverty rate of 7.8, is significantly lower than the poverty rate for the State of Wyoming. The poverty rates in Big Horn, Powder River, Rosebud and Yellowstone Counties do not exceed the Montana poverty rate.

Table 3–76 Percentage of the Total Population by Selected Age Groups by County and State in 1999

Location	0-4 years (percent of population)	5-17 years (percent of population)	18-24 years (percent of population)	25-44 years (percent of population)	45-64 years (percent of population)	65+ years (percent of population)
Campbell County	7.8	24.8	9.7	32.0	20.5	5.2
Converse County	6.5	22.6	8.6	26.6	25.2	10.5
Johnson County	5.0	18.1	8.1	22.6	27.9	18.3
Sheridan County	4.9	18.7	9.0	25.2	26.9	15.3
State of Wyoming	6.3	20.1	11.2	26.5	24.3	11.6
Big Horn	9.3	27.4	10.1	25.3	19.7	8.2
Powder River	5.5	17.8	6.7	21.5	26.6	21.9
Rosebud	7.7	27.3	8.6	28	20.6	7.8
Yellowstone	6.0	18.6	10.3	26.9	25.1	13.1
State of Montana	6.0	19.3	10.1	26.3	25	13.3

Source: U.S. Census Bureau 1999

Table 3–77 Percentage of the Total Population by Poverty Level by County and State for 1997

Location	Poverty Rate
Campbell County	7.8
Converse County	12.6
Johnson County	13.0
Sheridan County	12.5
State of Wyoming	12.0
Big Horn	15.5
Powder River	15.3
Rosebud	15.5
Yellowstone	12.1
State of Montana	15.5

Source: US Census Bureau 1997.